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DEVICE 2E6 (ACMS) AIR COMBAT MANEUVERING SIMULATOR  
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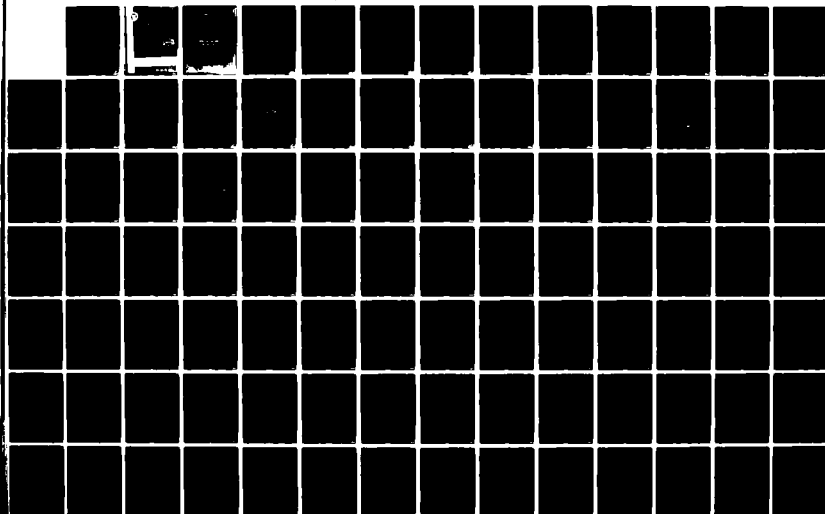
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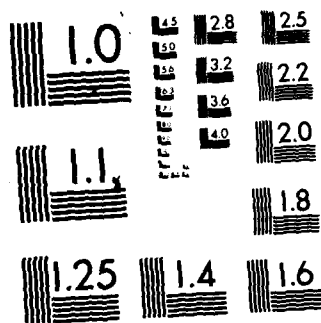
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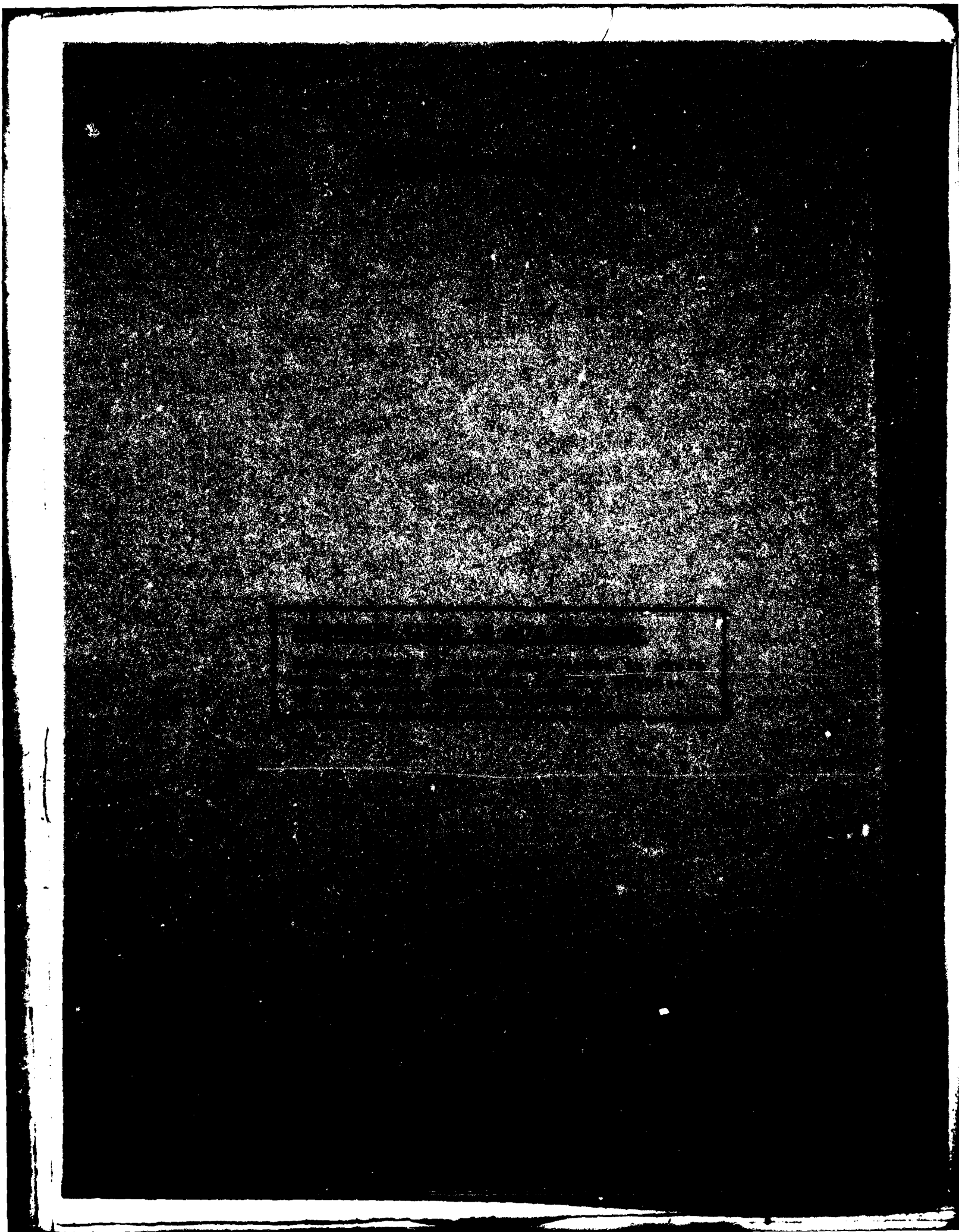
DATA AND (ACMS)  
RECOVERING SIMULATED  
CONSOLE REVIEW

John P. Charles  
ICON, Inc.  
San Diego, CA 92106

December 1980

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## SUMMARY

Two earlier surveys of the Instructor Operator Stations (IOS) of weapon system trainers (WST) conducted by the Naval Training Equipment Center following reports of problems, revealed a wide variety of design problems. The problems impacted on trainer effectiveness, especially in terms of operability and manning requirements. The surveys verified that significant improvements could and should be made to the IOSs and that changes to the design and procurement process should be implemented. The majority of the problems were considered to stem from the lack of adequate training front-end analysis and from the lack of application of existing human engineering criteria and design data.

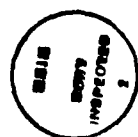
This report covers a survey of the IOS of a part-mission trainer, Training Device 2E6, an Air Combat Maneuvering Simulator. The device is significantly different from the WSTs surveyed previously (Device 2F119 and Device 2F112) in terms of the training objectives and in the characteristics of the trainer. The training objectives are concerned exclusively with the visual attack phase of air-to-air combat. Thus the environment and vehicle simulation requirements are limited and the training events consist of multiple relatively short duration flights.

Training Device 2E6 consists of two domes inside which is projected the simulated visual world and which house the training mockups. Two IOSs are provided so that the two training mockups can be operated as independent trainers. The two trainers can also be "tied" together and operated as a single training device.

The survey of the IOSs included reviewing technical documentation for the device, observing training operations and interviewing instructors, mission operators and technical personnel supporting the trainer. In addition, operating procedures were analyzed. The goal was to identify console design deficiencies and develop feasible solutions, for both short and long term.

A wide variety of problems were found ranging from basic human engineering defects to utilization and related instructor manning and training problems. Some console problems were created when professional operators were employed to support the instructors in the operation of the device. While solving instructor training problems and providing effective standard operation of the device, serious problems were created since the console was not designed for such manning. As a result, for example, the squadron instructor's station provides very limited control over training features and training events.

Among the conclusions reached was that significant improvements could and should be made to the IOS to enhance training and increase the effectiveness of the instructor as well as of the



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mission operator. While the device provides some new features which support training such as a debrief facility and a computer based instructor training module, the implementation limits their effectiveness. The major problems found include the following:

a. The instructor station displays and controls are inadequate for the instructor to effectively monitor aircrew performance and manage the training event. The required controls and displays are centralized at the Mission Operator station.

b. Insufficient flight and system information is available for the instructor pilot to "fly" the manual target/aircraft. In addition, the task conflicts with the basic instructor function of monitoring student performance and controlling the training event.

c. The CRT display pages do not provide sufficient information for the initialization and control of the training events without extensive paging and mode changes.

d. A wide variety of control and display design problems exist which although individually minor, combine to effect training operability and trainer capability utilization.

e. The arrangement of the consoles in the training spaces is not optimum.

f. Basic operating procedures such as initialization, debrief implementation and demonstration development are complex and error producing.

g. As found in the other surveys, user documentation for the IOS is limited and not designed for the user or for the functions which must be performed.

A series of recommendations were made to enhance the IOSs. Primary among these was that a display and control analysis be completed before any changes are made to ensure that the instructor and MO requirements are well defined and reflect the altered tasks. The detailed recommendations included:

a. Redesign the instructor's station to provide the required controls and displays for monitoring aircrew performance and for managing the training.

b. Reorient the consoles to provide some isolation of the stations from the traffic and congestion in the area.

c. Implement a performance measurement system to provide the instructor objective data to aid his evaluation of aircrew performance.

d. Simplify the basic operating procedures such as event initialization, debriefing implementation and demonstration development.

PREFACE

As pointed out in the previous studies of instructor's operating consoles for training devices, any survey and review of an existing trainer will in all probability find a variety of deficiencies and discrepancies. These should reflect changes to the syllabus as well as unanticipated interactions, following changes not only to the weapon system, but to the mission and the system's employment. However, as found in the previous studies, a wide variety of problems were found in Device 2E6 which should not have occurred had adequate human factors engineering analysis and design been completed as part of the device development effort. These problems range from relatively simple human engineering defects to major training function deficiencies.

While a great many officers and men contributed and helped in coordinating the data collection and analysis, the efforts of the following should be recognized. Their cooperation is greatly appreciated.

Mr. Robert J. Goodwin, Commander Naval Air Force U. S. Atlantic Fleet staff who sponsored and coordinated the visits to the user activities at the NAS Oceana, Virginia.

LCDR C. B. Bateman, Commander Fighter Wing One staff who directly arranged for the on-site survey at NAS Oceana and provided the device orientation, its development history and its current utilization.

Master Chief Hilton, FASOTRAGRULANT DET Oceana, who as leading chief for Device 2E6, provided the essential source of technical data.

Mr. "Doc" Hamburger of PSI, Inc. and a Mission Operator for Device 2E6, who provided the expertise on system operation and syllabus implementation.

The overall support of the Fleet Readiness Squadrons, Fleet Squadrons, and Adversary Squadron training staffs was critical to the evaluation, especially in terms of training requirements.

The cooperation of the FASOTRAGRULANT Detachment personnel was particularly helpful in resolving technical details and in clarifying system operations.

Overall, the interest and support of all the personnel contacted who were involved with Training Device 2E6 was outstanding. Their interest and assistance in identifying problems and structuring feasible solutions was instrumental in the completion of this report.



NAVTRAEQUIPCEN 82-M-0767-1

FOREWORD

This report is the third of a series sponsored by the Human Factors Laboratory of the Naval Training Equipment Center in which the functioning of the instructor/operator stations of modern training devices is examined. The effort is to provide data which will form the base for guidelines and functional specifications for the operation of the consoles that must support interaction between instructional personnel and training devices. Previous reports (NAVTRAEQUIPCEN 81-M-1083-1 and 81-M-1121-1) present analyses of Devices 2F119 and 2F112, and the present one documents a similar analysis of Device 2E6, the F-14A Air Combat Maneuvering Simulator at NAS Oceana.

*G. L. Ricard*

G. L. Ricard

Scientific Officer

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SECTION I

INTRODUCTION

BACKGROUND

Following reports of operating difficulties with some of the latest weapon system trainers (WST), the Naval Training Equipment Center (NAVTRAEQUIPCEN) undertook some surveys to document the problems. The objectives were to identify and analyze instructor operating station (IOS) design deficiencies and to develop conceptual solutions and design approaches to prevent similar problems in future procurements.

This report documents the third survey completed. It addresses the Air Combat Maneuvering (ACM) simulator, Device 2E6 located at the Naval Air Station (NAS) Oceana, Virginia. The previous surveys involved the EA-6B WST [1] and the F-14A WST [2]

The two previous surveys reported a wide range of IOS design and operating problems reflecting the lack of application of basic human engineering criteria and the failure to fully consider user requirements, characteristics, and constraints. In addition, the trainers did not provide support to many of the training functions involved in aircrew training.

DEVICE 2E6

Device 2E6 is a dual, fixed-base, part-mission trainer. The two trainers can be operated independently or in an integrated mode as a single trainer. Each trainer consists of a 40 foot dome inside which is located the cockpit training mockup. The visual world for the aircrew is projected on the inside of the dome. Figure 1 depicts the overall layout of the trainer.

The trainer includes the following major subsystems:

- a. projection domes,
- b. cockpit mockups,
- c. projection equipment,

-----  
1. Charles, John P. Device 2F119 (EA-6B WST) Instructor Console Review. Technical Report NAVTRAEQUIPCEN 81-M-1083-1, Naval Training Equipment Center, Orlando, FL. November, 1982.

2. Charles, John P., Device 2F112 (F-14A WST) Instructor Console Review. Technical Report NAVTRAEQUIPCEN 81-M-1121-1, Naval Training Equipment Center, Orlando, FL (in printing).

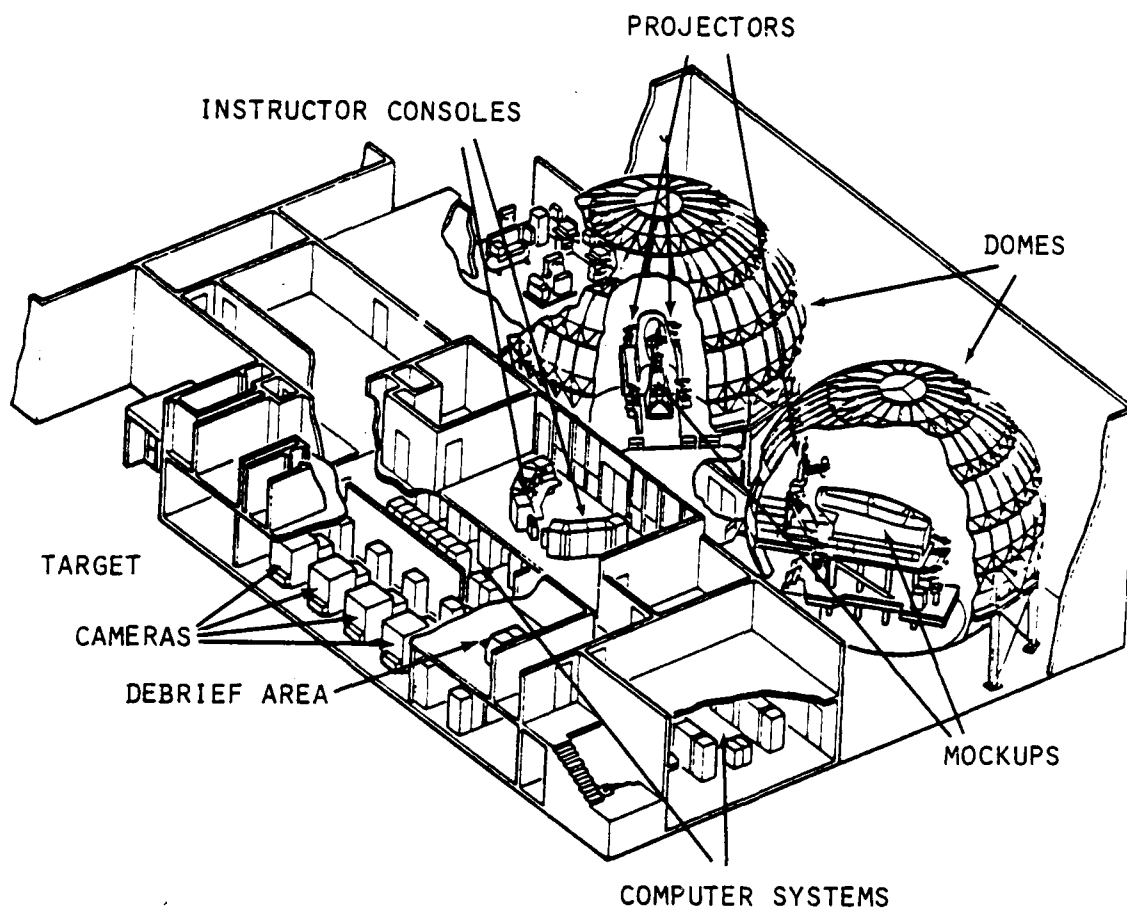


Figure 1. General arrangement (2E6)

- d. instructor stations,
- e. computer systems,
- f. target model subsystem,
- g. debrief subsystem,
- h. auxilliary subsystems.

The projection domes and projection equipment provide effectively a 360 degree visual scene as viewed from the cockpit. In addition to the visual reference world, up to two aircraft and one missile (in-flight) can be projected.

Mockups of both the F-14A and the F-4 aircraft are available. Changing the mockup in a dome requires about one day for installation and calibration.

Two instructor/operator stations are provided. Each station operates a trainer in the independent training mode. Either console can operate the entire device in the integrated mode.

Two computer systems support the device and operate either independently or together to support the two training modes. In addition, a small computer system supports the debriefing capability.

The target model systems provide for video generation of selected target models for projection in the domes.

The debriefing system provides for replay of a training event under instructor control. The debriefing station consists of two cathode ray tube (CRT) displays and associated controls. Any of the IOS displays are available at the station to aid in debriefing of the aircrews.

The auxiliary systems include the electrical and pneumatic support subsystems required by the device.

**CAPABILITIES.** Training Device 2E6 is a part-mission trainer providing air combat maneuvering training for F-14 and F-4 aircrews. Both aircraft carry a pilot and a Naval Flight Officer (NFO) as a Radar Intercept Officer (RIO). Since air combat maneuvering training is concerned primarily with the visual attack phase of air combat, the trainer simulation program is limited to the in-flight, close-in engagement envelope. Other design characteristics include:

- a. no takeoff or landing simulation,
- b. limited cockpit instrumentation simulation,



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- c. limited radar simulation (no radar display).
- d. no navigation simulation,
- e. no wind or turbulence effects,
- f. no ground texture change with altitude,
- g. only one in-flight missile projection.

The trainer simulation capabilities include:

- a. 1 on 1 ACM
- b. 2 on 2 ACM,
- c. instructor controlled adversary (at the IOS),
- d. computer controlled adversary,
- e. weapon simulation (AIM-7F, AIM-9L, and M61A1 gun),
- f. visual cues (as projected in the dome),
- g. "g" cues (through a "g" seat and "g" suit),
- h. audio cues,
- i. six target options (F-4J, F-4S, F-14A, F-18A and two threat aircraft),

In terms of training, the device provides for:

- a. aircrew interaction with:
  - (1) up to two programmed targets (PT),
  - (2) an Instructor Pilot (IP) controlled aircraft (target or friendly),
  - (3) any mix of these options for a three aircraft scenario.
- b. replay of the attack in the dome (without control mechanization) of up to the last 10 minutes of simulation,
- c. demonstration in the dome of prerecorded attacks,
- d. up to 32 initial conditions (IC), 16 in the independent mode, and 16 in the integrated mode,
- e. parameter recording of up to 15 parameters to preset tolerance levels,

- f. hard copy of displays used in training or debriefing,
- g. hard copy summaries of each intercept run,
- h. debrief of each event at a remote facility,
- i. IP/operator training in console operation,
- j. settable flags/pointers to aid in replay and debrief,
- k. audio replay for debrief,
- l. simulation of relevant cockpit displays and controls.

MODES OF OPERATION. The trainer is capable of operating in a variety of modes and submodes to support aircrew training. In addition to the independent and integrated modes which provide the options of training two aircrews in different problems simultaneously or in using the two domes in the same problem, the following trainer modes are available:

- a. Standby Mode - the trainer systems are "on" but no operating mode has been selected,
- b. Plan Mode - provides for preprogramming ICs at the IOS,
- c. Training Mode - provides for initializing and conducting training,
- d. Demonstration Mode - provides for the replay of prerecorded attack simulations,
- e. Instructor/Operator Training Mode - provides a computer managed training module for training in console operation,
- f. Debrief Mode - although not a mode controlled from the IOS, the feature is an integral part of training, is generated at the IOS and utilizes a similar control console.

INSTRUCTOR OPERATOR STATION. Each of the IOSs are identical except for some switch labels. Figure 2 depicts the overall layout and arrangement of the console. The CRTs have been labeled "1," "2," and "3" to facilitate discussion. The console panels containing CRTs 1 and 2 are used primarily for monitoring the problem and aircrew performance, and for manually flying the IOS controllable aircraft. The panel containing CRT 3 is used primarily for controlling the trainer in conjunction with the Systems Panel, which provides information and control of the simulation subsystems and communications with other training device locations (other than the cockpit

Figure 3 depicts CRT 1 panel. In contains switches for selecting communic

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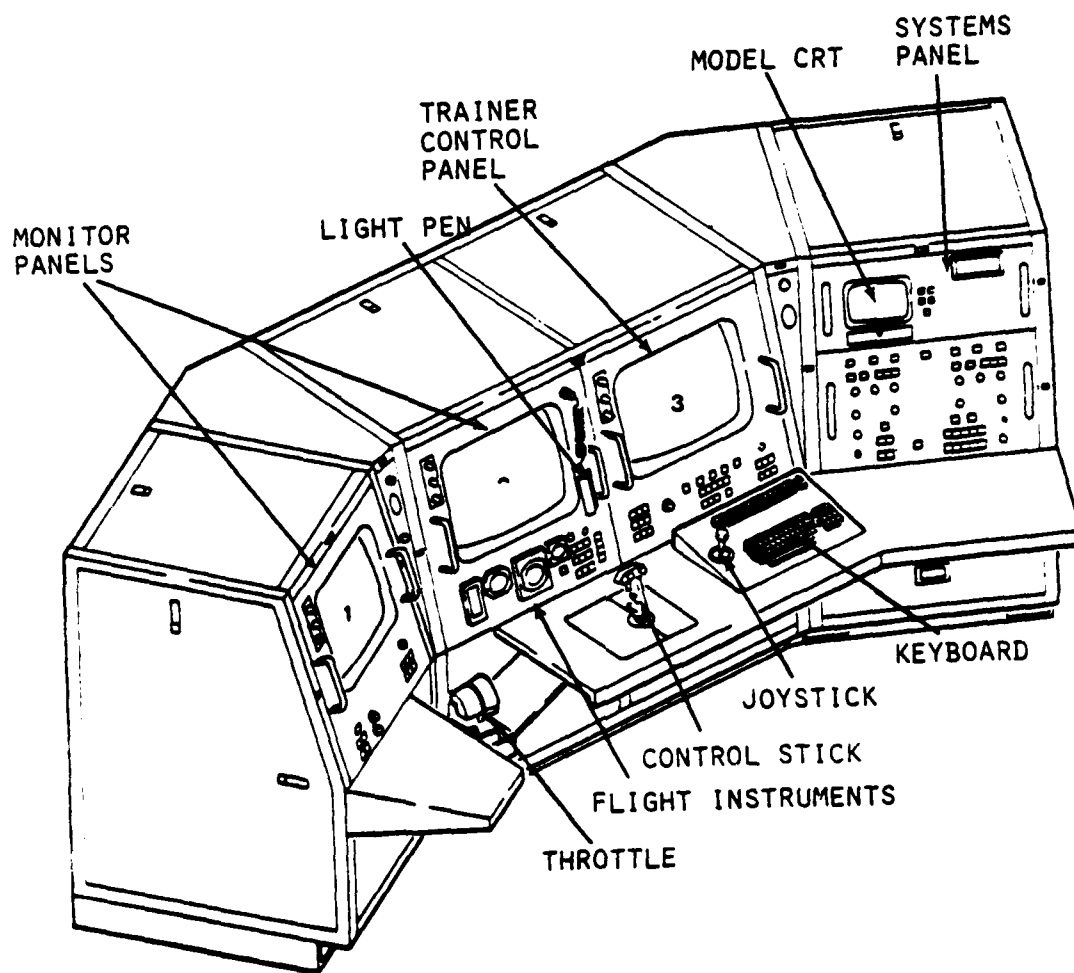


Figure 2. Instructor operator station

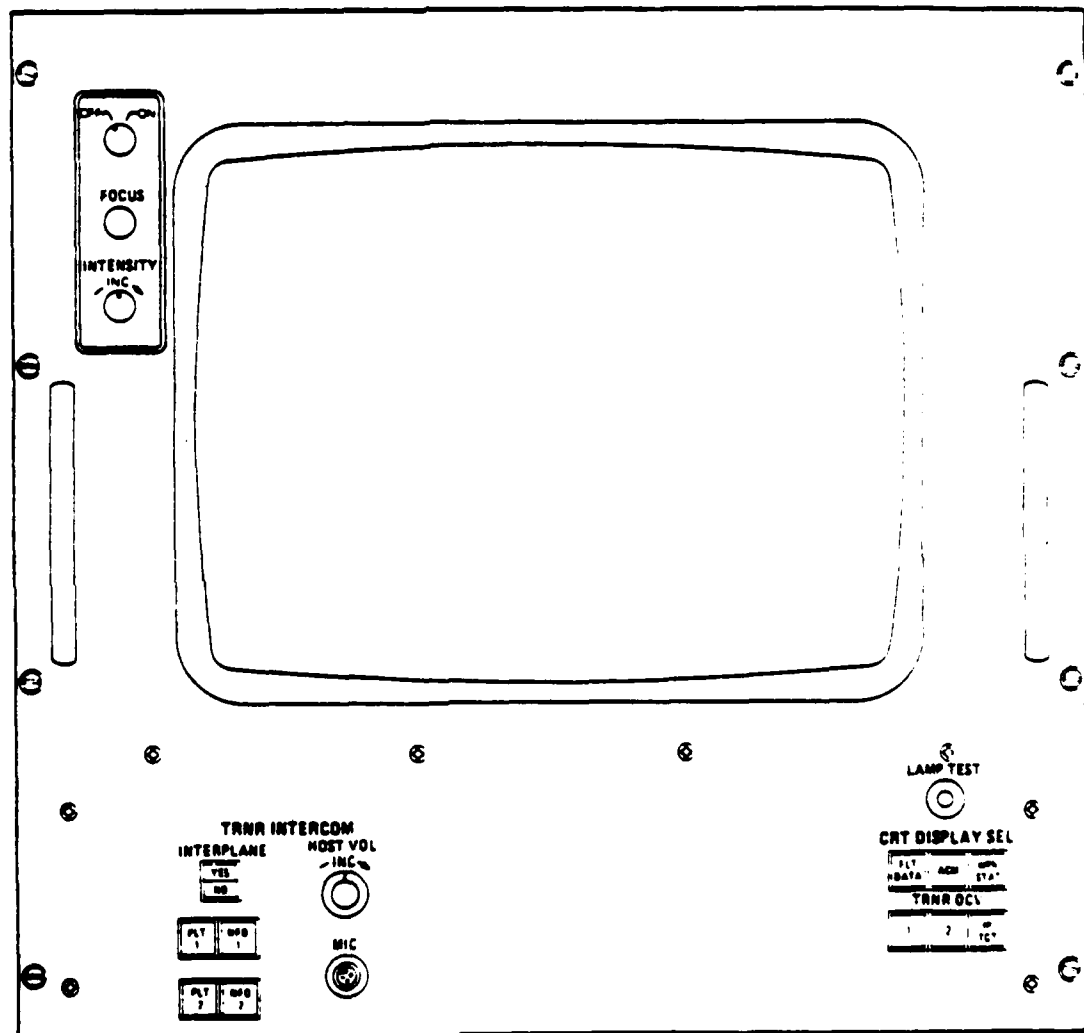


Figure 3. CRT 1 panel

When operating in the integrated mode, the switch marked "INTERPLANE" "YES" is selected, and provides the option of selecting any one or all of the aircrew stations in the two domes. In the independent mode, only communications with the aircrew in the dome being controlled from that IOS is available using one set of the "PILOT" and "NFO" switches. The switches at the bottom right of the panel provide for selecting display options (common to all three CRTs). These include the Flight Data display (see Figure 4), the ACM display (see Figure 5), the Weapons Status display (see Figure 6) or the "Out-of-Cockpit View" (OCV) (see Figure 7).

Figure 8 depicts CRT 2 panel. In addition to the CRT, it contains the following:

a. selected flight instruments to facilitate manual control of a simulated aircraft from the IOS. The instruments are arranged below the CRT and include:

(1) Relative Altitude indicator. This unique indicator with a fixed scale and two moving pointers is used to display the relative altitude of the various aircraft in the problem.

(2) Bearing-Distance-Heading Indicator (BDHI). The BDHI is used to display the relative bearing of the aircraft in the problem with the compass card indicating the heading of the selected reference aircraft.

(3) Attitude Director Indicator (ADI). The ADI indicates the attitude of the selected aircraft. The needles are inoperative.

(4) Angle of Attack indicator. The indicator shows the angle of attack of the selected aircraft.

b. "COPY FLAG" switch. The switch permits the insertion of an event "marker" for use in replay, demonstration or debrief.

c. "FLY LIMIT" switch. The switch selects the preset "g" limits which constrain the manual control of the aircraft flown from the IOS.

d. "TRNR INSTR" switches. These switches permit selection of the instrument readouts.

e. CRT display selection switches (same as on the CRT 1 panel).

f. Hard copy print switches. These select the CRT to be printed (the top switch is a spare).

g. Light pen. The control provides for CRT initiated control functions. Only one light pen is available.

A control stick is located on the counter below the panel

RUN 3 5/25/79 10:08:43 TIME 0					
AIRCRAFT DATA			RELATIVE DATA		
A/C	TRI F-4J	PT THRT 2	R	TRI/PT 3.3	PT/TR1 3.3
IMN	0.80	0.89	VC	-50	-50
IAS	450	500	AOT	10	190
ALT	10000	10000	ATA	10	0
G	1.0	1.0	BRNG	15	195
AOA	7	5	ELEV	0	0
HEADING	0	0	WEAPON DATA		
ROLL	0	30	MASTER ARM	TR1	OFF
PITCH	-10	20	MSL PWR/MSL PRP	OFF	OFF
PITCH RT	0	0	SW COOL	OFF	OFF
ROLL RT	0	0	INTERLOCK/ACM	OUT	OUT
YAW RT	0	0	MISSILE MODE	SEAM	SEAM
THRTL	100	80	VTAS PWR (F-4J)	OFF	OFF
SPBK	IN	OUT	GUN RATE (F-14)		
FLAPS	0	0			
FUEL	80	70			
PS	520	640			
ES	28	34			

Figure 4. Flight data display

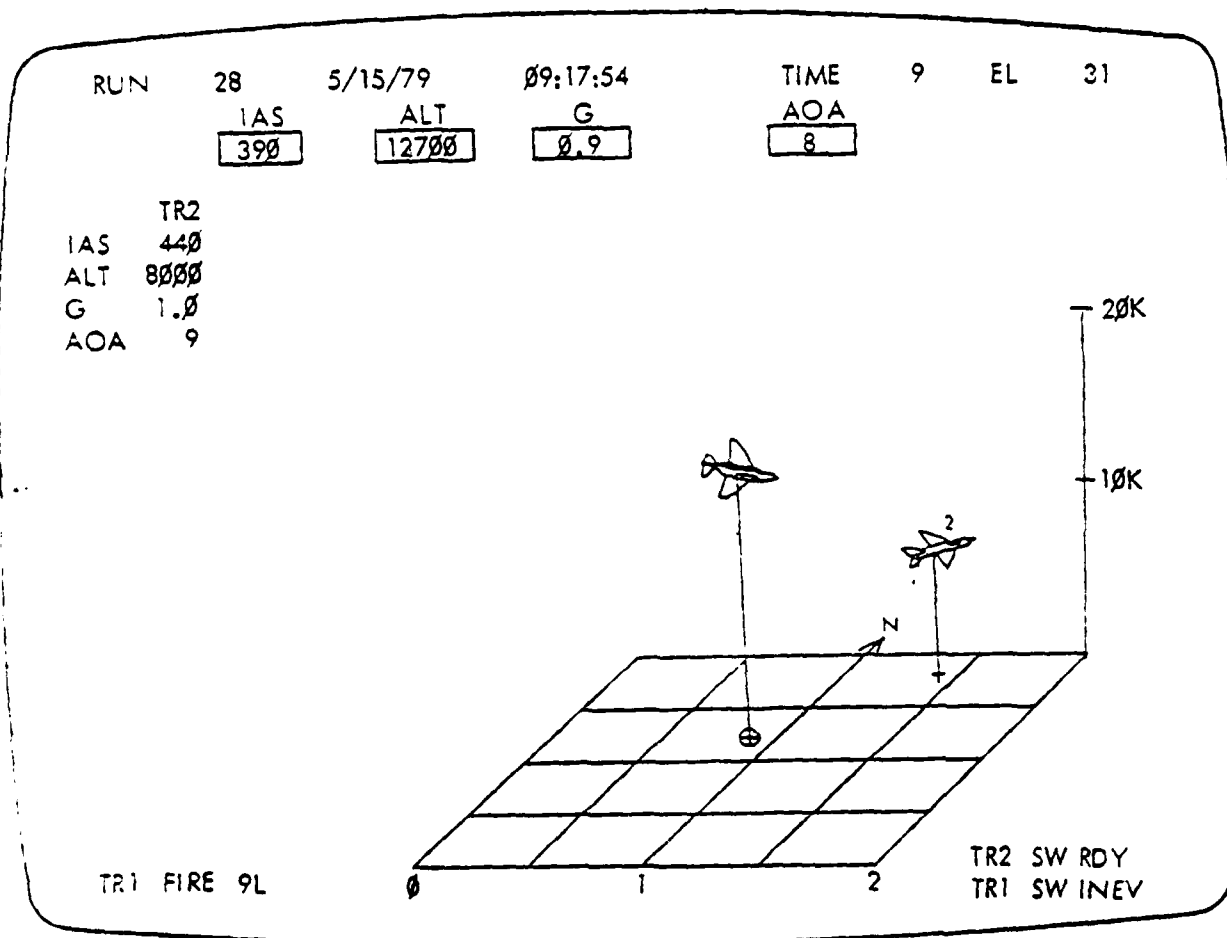


Figure 5. ACM display

RUN 3		5/25/79	10:12:41	TIME 4
TRI F-4J				PT THRT 2
MASTER ARM	ON			
MSL PWR/MSL PREP	ON			
SW COOL	ON			
INTERLOCK/ACM	OFF			
VTAS PWR (F-4J)	ON			
GUN RATE (F-14)				
WPN SELECT	SW			SW
RADAR MODE	LCK PT			SRCH
WPN STATUS	RDY			RDY
RNDS REM				200
SW/SP REM	4/2			4/4
GUN HITS 10/20				0/0
MISSILE SHOTS	1	2		
TYPE	AIM7F	AIM7F		
TGT	PT	PT		
KILL	NO			
REASON	FUSE	INFLT		
R	1.1M	1.0M		
VC	50	45		
AOT	5	0		
ATA	15	0		
IAS	604	550		
ALT	10100	10300		
G	1.0	1.1		

Figure 6. Weapon status display



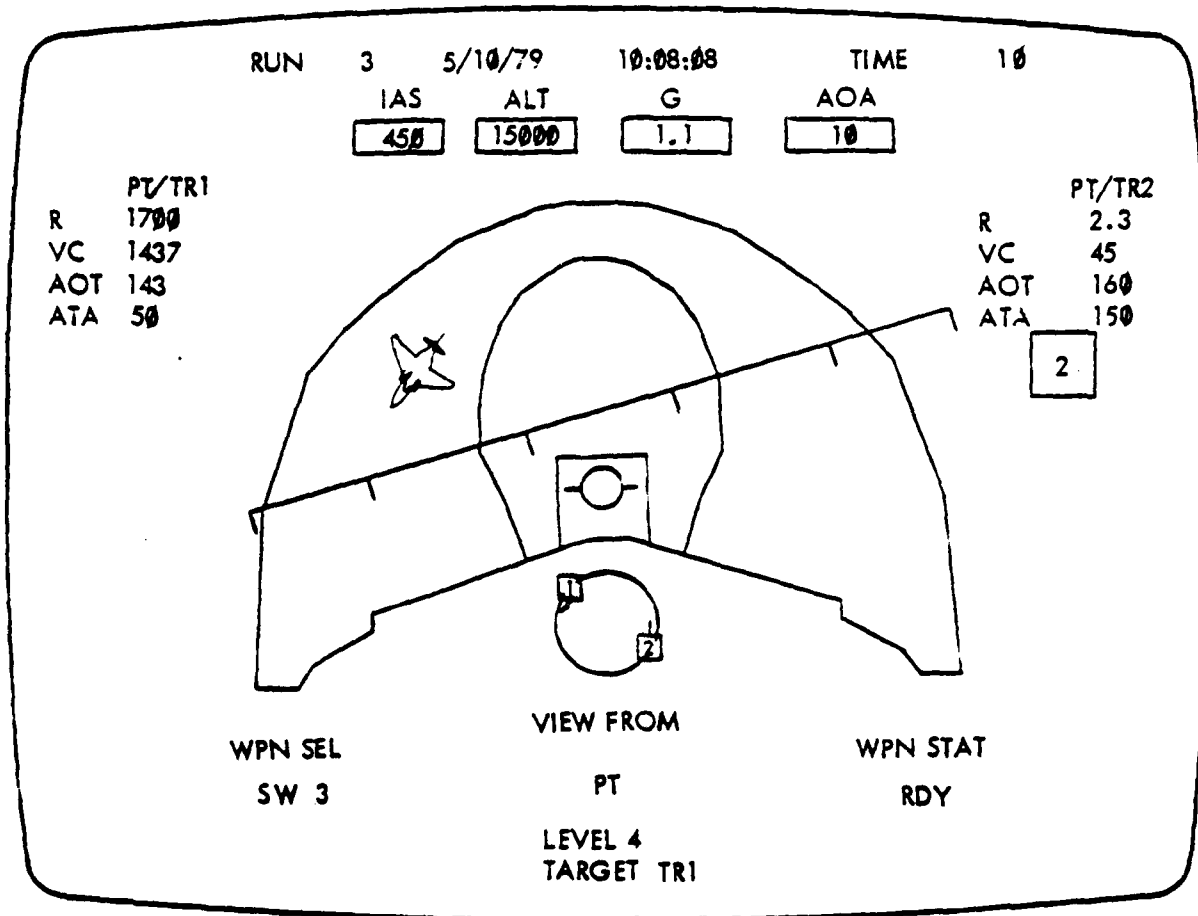


Figure 7. Out-of-cockpit view display

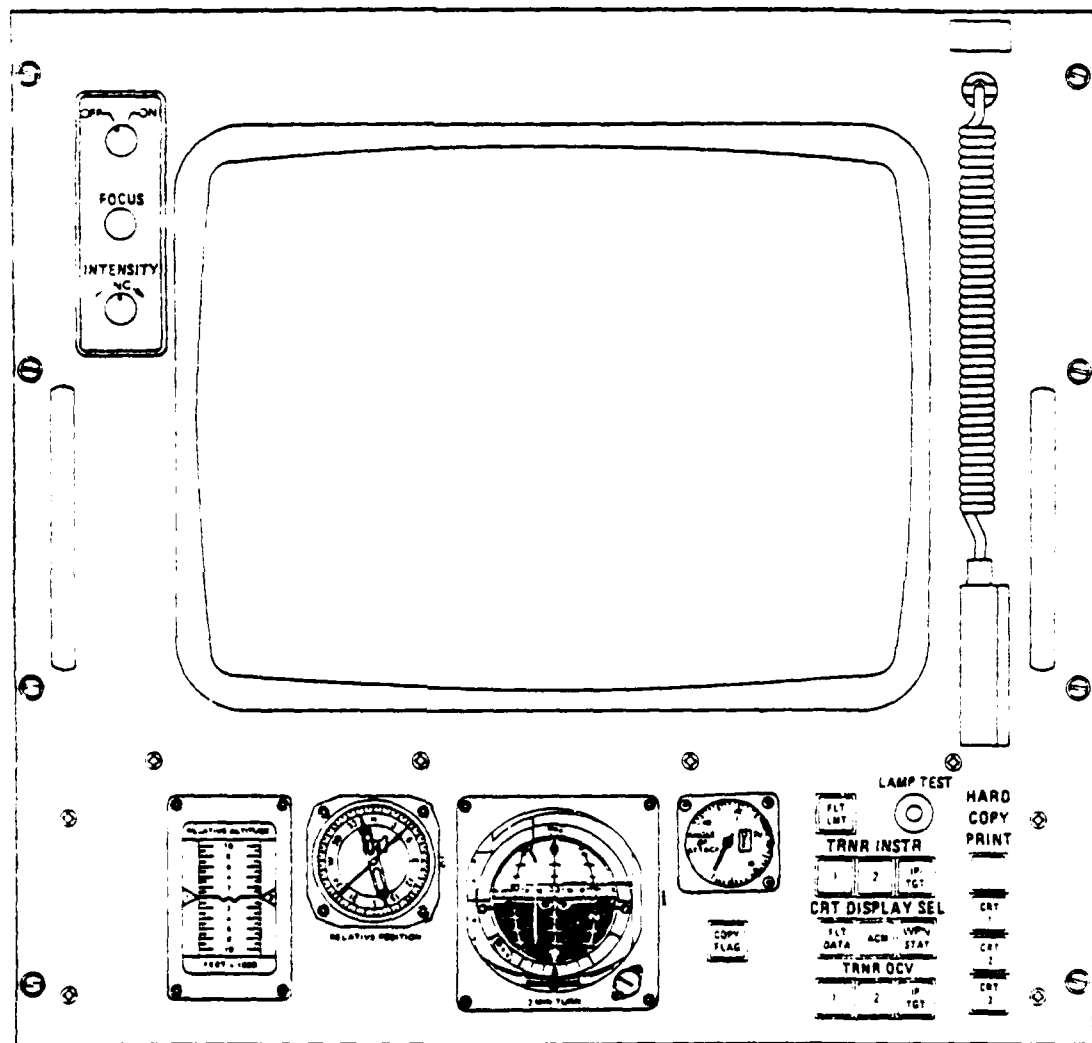


Figure 8. CRT 2 panel

and in addition to providing pitch and roll control for the IP flown aircraft, it incorporates switches for weapons select, trigger, target/slave/acquisition, trim control and a switch to activate the event marker. A separate switch to control ACM display orientation is also incorporated.

Figure 9 depicts CRT 3 panel which is used primarily for trainer control. In addition to the CRT and related switches common to all of the CRTs, it includes the following switches and controls:

a. "ACM CONTROL" switches for selecting the ACM display options. These include selection of the grid scale control (manual or automatic), scale factor (manual option only), wing trace duration, zoom control, and joystick control option (ACM display orientation or centering). In "ORNT," the joystick moves the ACM display in the yaw and pitch axes; in "CRT," the joystick permits centering the aircraft and grid on the CRT.

b. Master Control Mode switches for overall mode control of the trainer and the training options available in the training mode. The five modes and characteristics will be reviewed briefly.

(1) Standby Mode - indicates system ready for use,

(2) Plan Mode - provides for generating or modifying initial conditions,

(3) Training Mode - provides for aircrew ACM training with submodes of freeze, reset, and replay. The following switches are also used in this mode:

- crash and crash alarm override switches,
- debriefing data record control switches,
- data print switch for hard copy,

(4) Demonstration Mode - provides for playback of previously recorded events,

(5) Instructor Training Mode - provides a self-teaching program on console operation.

c. Display select switches which provide the display options common to all the CRTs.

Figure 10 illustrates the keyboard which consists of a set of function keys, a numeric keypad (NKP), and a conventional computer alpha-numeric keyboard (ANKB). A small joystick is also located on this panel and provides for control of the ACM display in orientation and centering (as selected on the CRT panel).

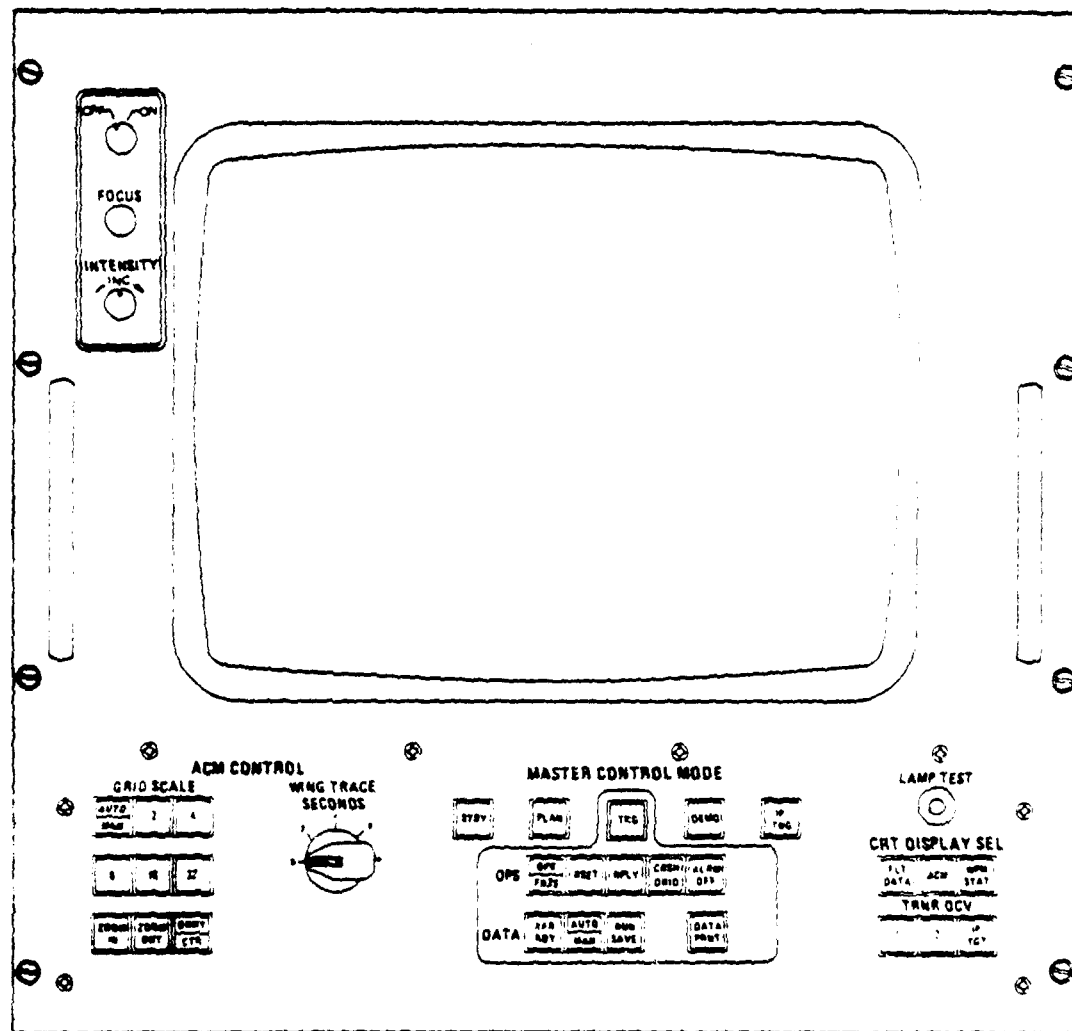


Figure 9. CRT 3 panel

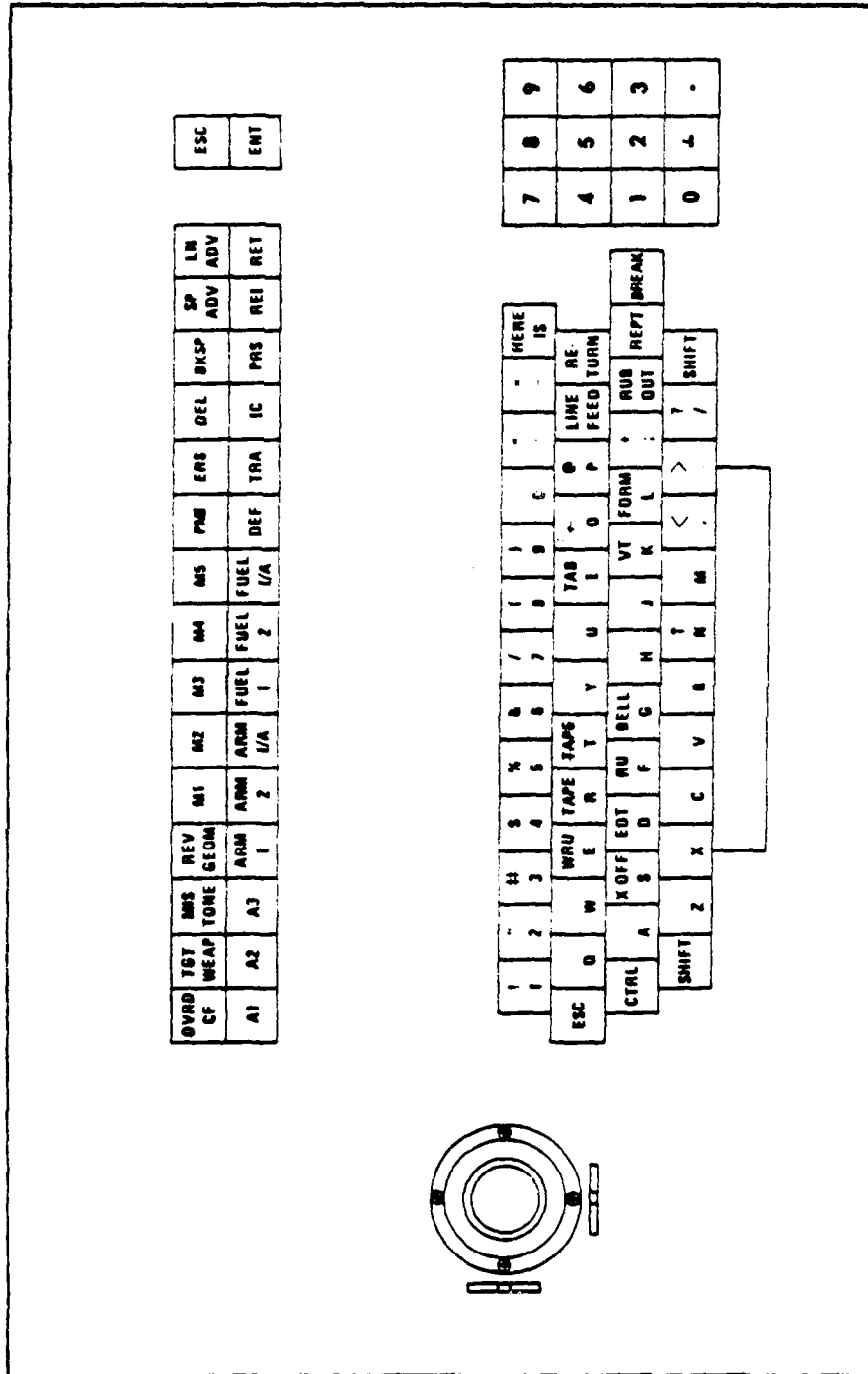


Figure 10. Keyboard

Figure 11 illustrates the Systems Panel. It includes two subpanels. The upper panel includes the CRT which monitors the selected model cameras. The lower panel contains switches and indicators for monitoring the trainer subsystem status, setting "g" and buffet levels, and selecting intercommunications, both to the trainers and to the maintenance and operating areas. Since the two trainers can be operated in an integrated mode, the systems panel provides switches and indicators for control of both trainers.

DEBRIEF STATION. Although not mechanically part of the IOS, the Debrief Station is functionally a part of it. Figure 12 depicts the station. It includes two CRTs and a keyboard along with controls and indicators. The debrief capability provides for replay of the training event displays and the communications which occurred within the IOS-cockpit(s) intercommunications system. Figures 13 and 14 depict the two display panels. With the exception of the Master Control Mode switches (see Figure 13), the switches and indicators are similar to those on the IOS panels. The Master Control Mode switches control the debrief system, providing options for freeze and reset in addition to the operate or run mode. The debrief station is located in a training room near the IOSs (see Figure 1).

CRT DISPLAY OPTIONS. In addition to the four display options available for monitoring training, i.e., flight data, ACM, weapons status, and out-of-cockpit views, a variety of displays are available in the different training modes to create and select initial conditions and training features. Table 1 lists the display pages available in the Plan Mode to create initial conditions.

Although 32 problems and IC summary pages are shown as available, only 16 are available in any one mode, i.e., 16 in the integrated and 16 in the independent mode.

TABLE 1. PLAN MODE DISPLAY PAGES

CODE	TITLE	PAGES	FUNCTION
PRS	Problem Summary	32	Review of key problem data
PMI	Plan Mode Initial.	1	Index and access to options
TMS	Training Mode Select	1	Select integ. or indep. mode
TA	Trainer Assignment	1	Select targets, opponents
AC	Aircraft Selection	1	Select aircraft types
ARM	Armament Selection	6	Select aircraft armaments
PR	Parameter Recording	1	Select parameters to record
TP	Tolerance Parameters	1	Select parameter tolerances
CC	Crash Conditions	1	Select crash criteria
FDI	Flight Data ICs	1	Index/access to IC numbers
FDIC	Flight Data IC	3	Review/modify selected IC
ICS	IC Summary	32	Review of all ICs

Table 2 identifies the displays available in the training

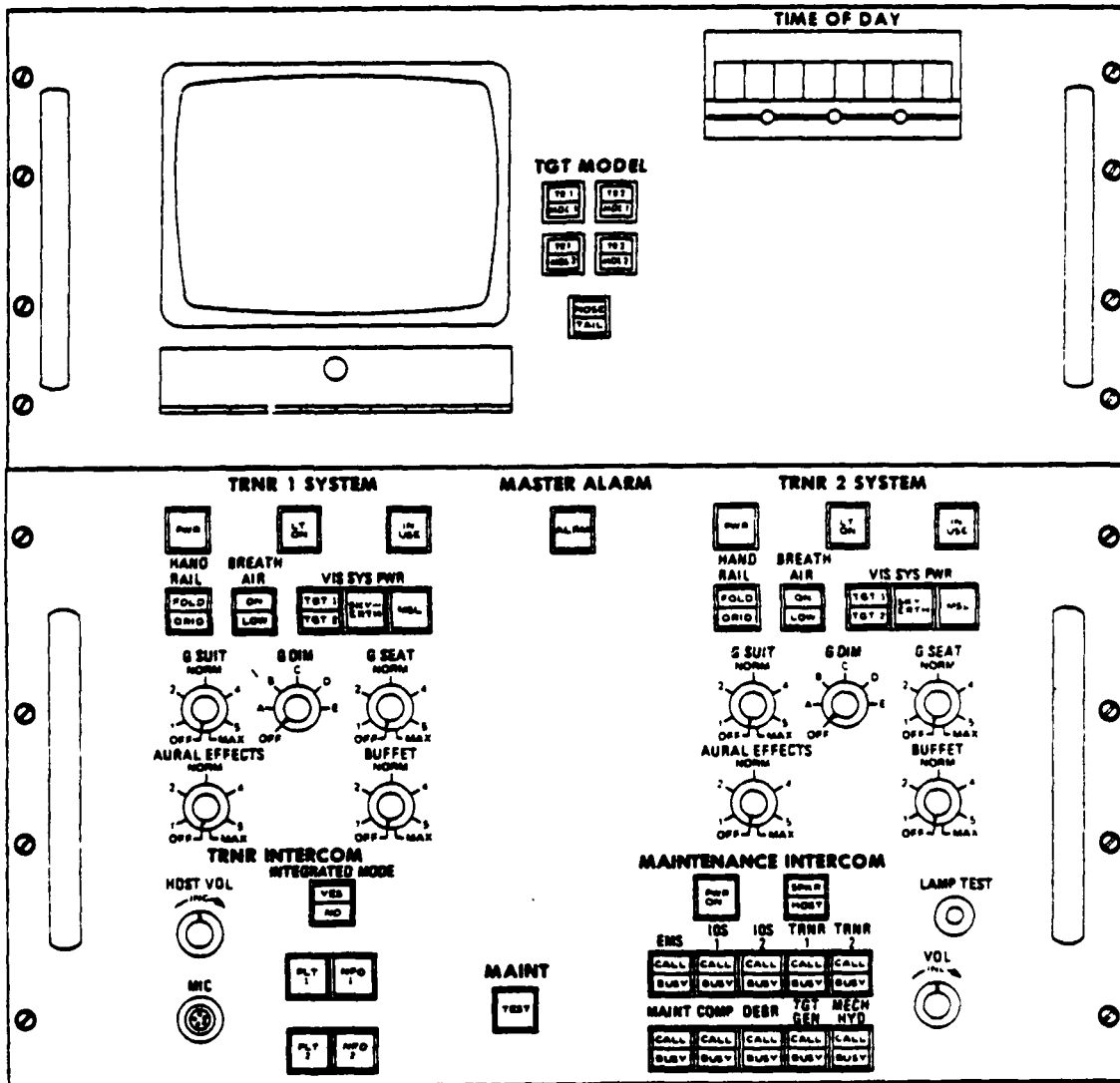


Figure 11. Systems panel

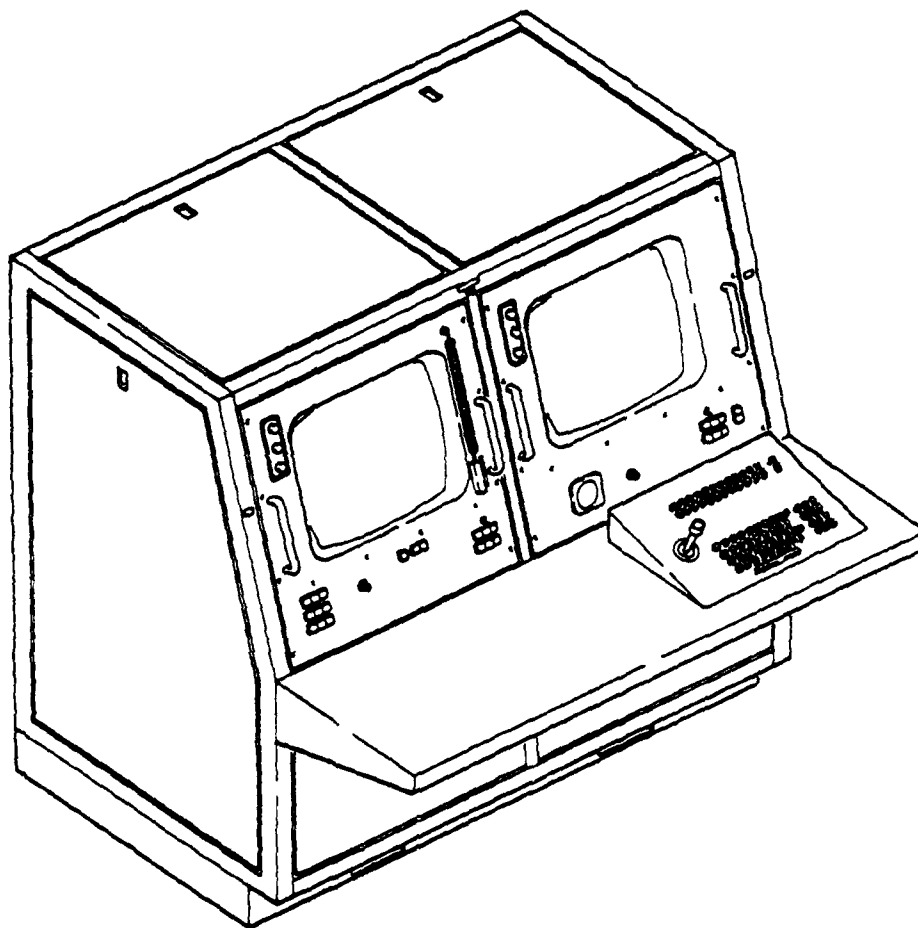


Figure 12. Debrief station



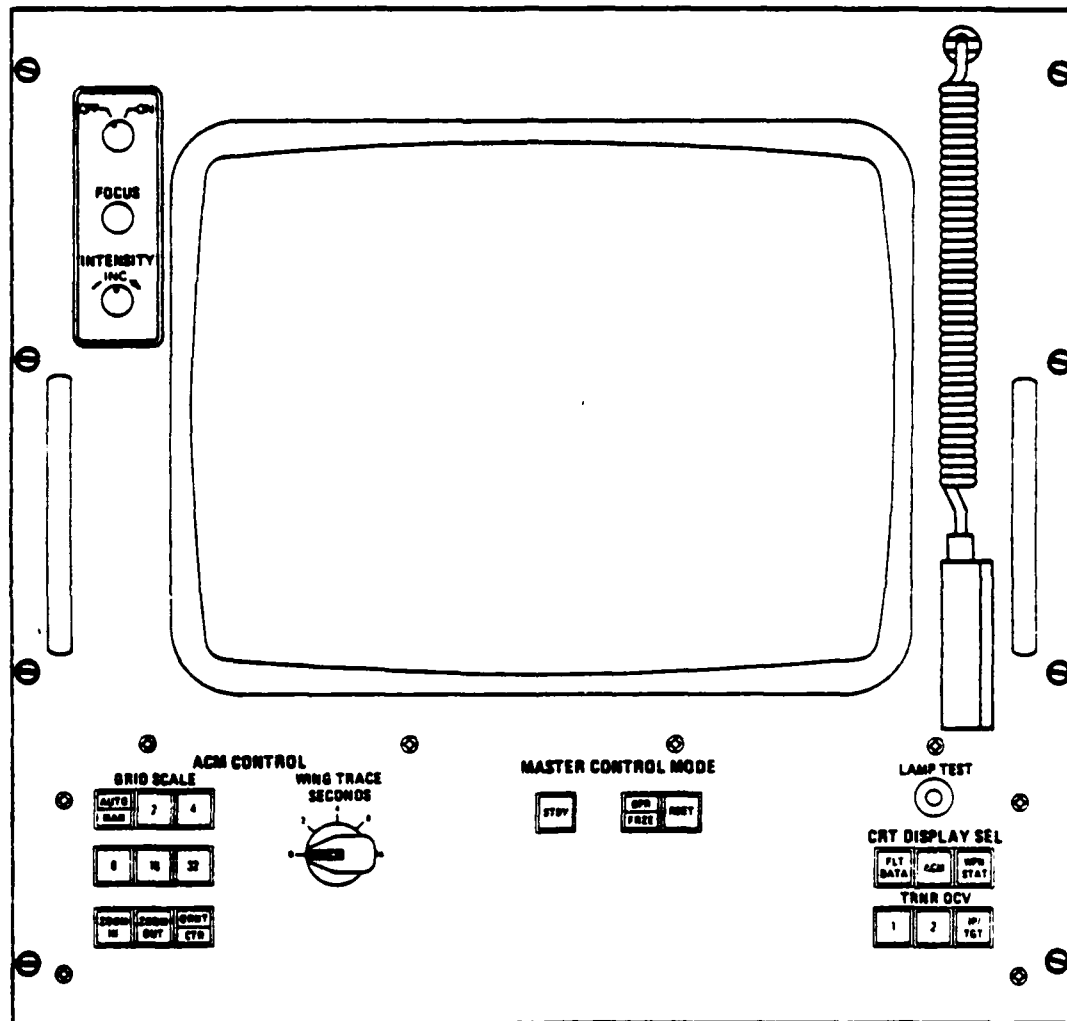


Figure 13. Debrief station, left panel/CRT 1

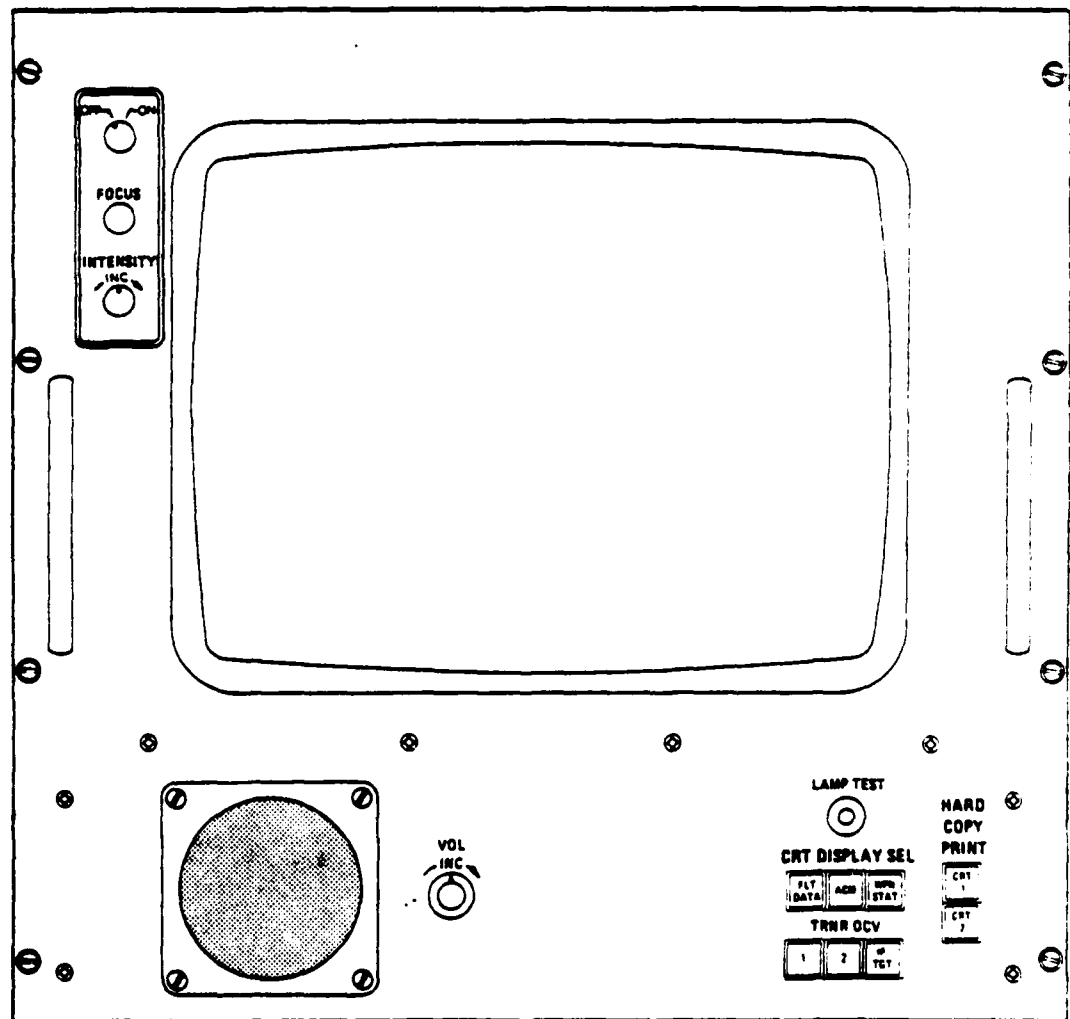


Figure 14. Debrief station, right panel/CRT 2

mode.

TABLE 2. TRAINING MODE DISPLAY PAGES

CODE	TITLE	PAGES	FUNCTION
TMS	Training Mode Select	1	Indep./Integ. mode select
PRS	Problem Summary	30	Review of key problem data
-	Reset Idle	1	Index/access to initial.
-	Demo Mode Select	2	Select/title demo recording
-	Trainee Data	1	Enter names, weights, etc.
IC	IC Summary	30	Review ICs
REI	Reset Idle Init.	1	Enter start time
PT/IP	PT Level/IP Limits	1	Enter control criteria
-	Copy Flag Comments	1	Enter comments at flags
-	Data Save	1	Summarizes record status
FLT	Flight Data	1	Monitor a/c flight
ACM	ACM	1	Monitor maneuvering space
WPN	Weapon Status	1	Monitor weapons status
OCV	Outside Cockpit View	1	Monitor pilot's view

The last four are the primary displays used during training.

Table 3 lists the display pages available in the Demonstration mode (which permits the playback of previously recorded exercises/events). Cockpit instruments, projected scene, and IOS displays are active during the presentation of the demonstration. Only the display pages unique to the mode are listed in Table 3.

TABLE 3. DEMONSTRATION MODE DISPLAY PAGES

CODE	TITLE	PAGES	FUNCTION
-	Run Selection	1	Select run to replay
-	Initialization	1	Select start time

The displays available in the IP training mode are the same displays listed in Tables 1, 2, and 3 with the addition of text to tutor the user in the operation of the console.

Table 4 lists the displays available at the Debrief Station. These displays are in addition to the four monitoring displays (flight data, ACM, weapons status, and OCV) selectable at the CRT panel.

TABLE 4. DEBRIEF STATION DISPLAY PAGES

TITLE	PAGES	FUNCTION
Run Selection	1	Select run number
Initialize	1	Enter run start time
Data Print	1	Select frequency and print

Since only two CRTs are available at the Debrief Station,

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only two of the four monitoring displays can be accessed at any time.

## SECTION II

### METHOD

#### GENERAL

A similar approach to that utilized in the previous surveys of instructor consoles was taken. This included the use of observation and operation/system analysis to identify problems and to structure feasible solutions. The results of the earlier studies were utilized as a point of departure and except where important to clarify a problem, the generic findings of the earlier reports are not duplicated in this report.

#### SURVEY

Visits were made to the NAS Oceana, Virginia to collect data on:

- a. current training syllabi,
- b. console operation,
- c. operating problems,
- d. trainer documentation,
- e. proposed and desired modifications.

Personnel from Commander Fighter Wing One (COMFITWING ONE), the F-14 and F-4 Readiness Training Squadrons (VF-101 and VF-171), the Adversary Squadron (VF-43), VF-14 and F-4 fleet squadrons, and the Fleet Aviation Specialized Operations Training Group Atlantic, Detachment NAS Oceana (FASOTRAGRULANT DET Oceana) were interviewed. Training syllabi, grade sheets, instructor and operator guides, device handbooks and locally developed operating instructions/procedures were collected and reviewed. Training operations were observed and procedures and problems encountered were documented.

#### ANALYSIS

Following data collection, analyses were completed to identify and structure:

- a. functions of the instructor(s) and operator(s) implicit in the design of the console,
- b. functions of the instructor(s) and operator in ongoing training.
- c. operating problems,

- d. design deficiencies,
- e. implementation problems.

Function flow diagrams and time line charts were developed where required to expose problems and verify data collected. In addition, these data proved useful in structuring and evaluating feasible solutions to the problems presented.

### SECTION III

#### RESULTS

##### GENERAL

The results of the study of the design and operation of Device 2E6 will be reviewed under the following major headings.

- a. current usage,
- b. basic design deficiencies,
- c. functional deficiencies.

Current usage addresses the different user's manning of the console as well as the utilization of the device in the training program. Basic design deficiencies address primarily the human engineering discrepancies in the layout of the console and in the design and mechanization of the controls and displays. Both static and dynamic problems are considered. The static problems are those which result from lack of application of basic human engineering design criteria such as are contained in existing standards and in accepted Navy aircrew station design practices. The dynamic problems are concerned with usage and reflect deficiencies in the design of the interface between the operator or user, the console, and the training program.

Functional deficiencies consider the problems involved in utilizing the trainer in meeting training requirements. The generic set of training functions utilized in the other surveys was used (see Appendix B).

##### CURRENT USAGE

Both manning of the console by the various users and utilization of the trainer modes were analyzed.

CONSOLE MANNING. During the initial installation and implementation of the Device 2E6, it was decided that specialized and experienced system operators would be required to effectively utilize the device. As a result, professional Mission Operators (MO) were engaged to operate the trainer. The survey of the device involved in this report reflects this manning concept.

The use of the MOs has resulted in the technician operator providing only "on call" maintenance support except for some relief operation of the device when required. Thus the technician operator does not occupy a console position except when relieving the MO at the console.

In general, the MO utilizes the number 3 CRT position with

the keyboard and the adjacent Systems Panel. The squadron instructor normally sits in front of CRTs 1 and 2 where he can utilize the stick and throttle to manually "fly" a simulated aircraft or target. Figure 15 depicts this utilization. However, MO and IP share all three CRTs since they are required for the display of the information necessary to monitor the aircrew's performance and to fly a simulated aircraft/target.

The actual display pages used on the three CRTs during training typically consist of the Weapons Status Display on CRT 1, an "Out-of-Cockpit View" on CRT 2 and the ACM display on CRT 3. Thus the IP seated at CRT 2 has in front of him, a view out of the cockpit (of the aircraft he is flying, a target aircraft, or of the trainer cockpit) and the ACM display to his right. He then utilizes CRT 1 for display of other pages such as flight data.

At the routine fleet squadron training events observed, the MO generally provided complete operation of the device and provided briefing and debriefing when required. However, trainer utilization and syllabus implementation procedures are being modified and finalized. Therefore detailed functions and roles of the IP and the MO are still evolving. It does appear that the MO will conduct most of the routine fleet squadron training events. Readiness Training Squadrons on the other hand, will generally man the console IP position for most training events including the Fleet Fighter ACM Readiness Program (FFARP) syllabus.

The primary aircrew training users of the 2E6 include the following:

- a. F-14 Fleet Readiness Squadron (VF-101),
- b. F-4 Fleet Readiness Squadron (VF-171),
- c. Adversary Squadron (VF-43),
- d. F-14 Fleet Squadrons,
- e. F-4 Fleet Squadron.

F-14 Fleet Readiness Squadron (FRS) Usage. The FRS syllabus includes five 2E6 training events. The squadron plans to utilize demonstrations in some of the events although all of the demonstrations had not been developed at the time of the survey. The debrief facility will also be utilized when available. Table 5 summarizes these events.



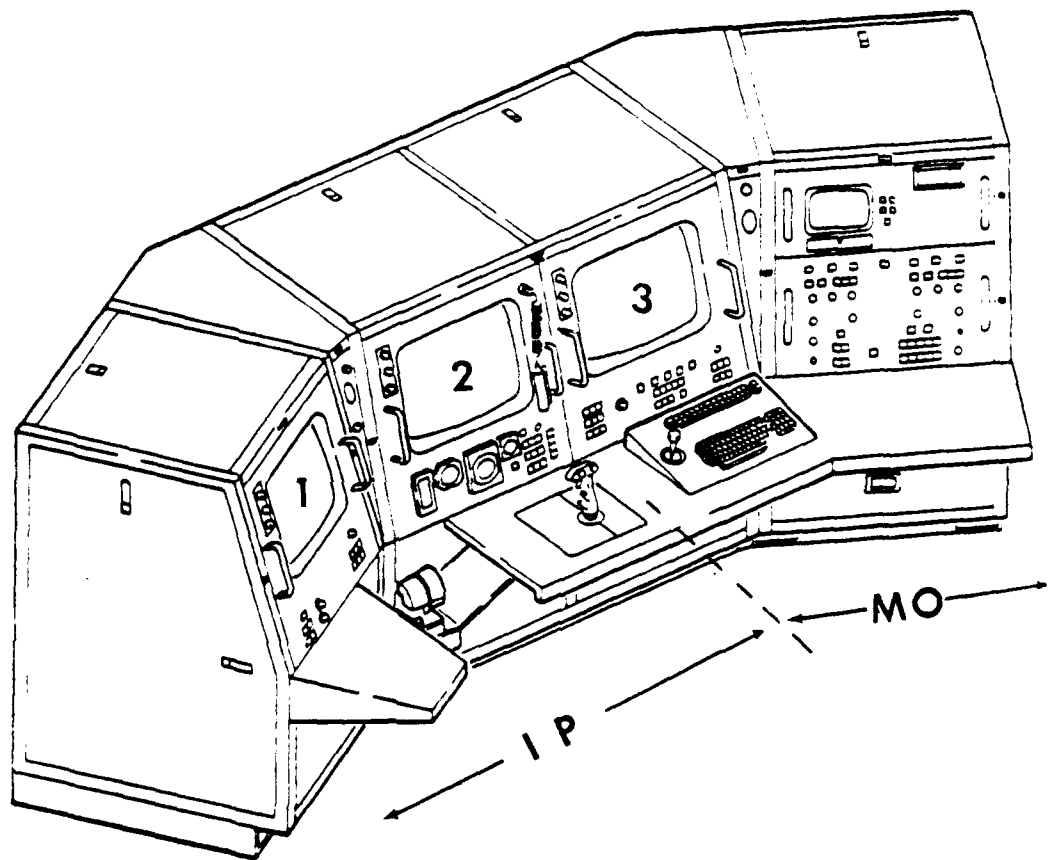


Figure 15. Console IP and MO areas

TABLE 5. F-14 2E6 TRAINING SYLLABUS EVENTS

<u>EVENT</u>	<u>TITLE</u>	<u>2E6 MODE</u>
BABT 020	1 v 1 Offens./def. Maneuvering	Integrated
BABT 030	1 v 1 Neutral Maneuvering	Optional
AABT 030	2 v 1 Maneuvering	Integrated
AABT 040	1 v 2 Maneuvering	Integrated
WGBT 010	A/A Gunnery - Canned Set-ups	Integrated

F-4 FRS Usage. The F-4 readiness training syllabus includes ten 2E6 training events. Table 6 summarizes these events.

TABLE 6. F-4 READINESS TRAINING SYLLABUS EVENTS

<u>EVENT</u>	<u>TITLE</u>	<u>2E6 MODE</u>
P/R 22.8	Intro Weapons, Departures	Optional
P/R 22.9	Practice Departures	Independent
P/R 22.10	Practice Tactics	Optional
P/R 22.11	AWG-10 Tactics	Optional
P/R 22.12	Practice AWF-10 Tactics	Optional
P/R 22.13	1 v 1 (Threat 1)	Optional
P/R 22.14	1 v 2 (Threat 2)	Optional
P/R 22.15	2 v 1 (Threat 1)	Optional
P/R 22.16	2 v 1 (Threat 2)	Optional
P/R 22.17	2 v 1 (F-14)	Optional

Events 22.10, .11, and .12 utilize demonstrations. Events 22.15, .16, .17, and .18 generally involve two aircrews, one in each trainer. An IP is utilized for all events.

Adversary Squadron Usage. The Adversary Squadron utilizes the 2E6 for the FFARP syllabus. Table 7 summarizes these events.

TABLE 7. FFARP 2E6 TRAINING SYLLABUS EVENTS

<u>EVENT</u>	<u>TITLE</u>	<u>2E6 MODE</u>
FFARP-01	1 v 1 Maneuvering	Independent
FFARP-02	2 v 1 Maneuvering	Integrated
FFARP-03	1 v 1 v 2; 1 v 2	Integrated

All events utilize an MO at the IOS. Event -03 requires an IP at the console also. Events -02 and -03 utilize both domes with an aircrew in each.

Fleet Squadron Usage. The Fleet Squadron usage of the 2E6 is outlined in the Commander Naval Air Force Atlantic Fleet (COMNAVAIRLANT) Instruction 3500.42 "Air Wing Readiness Training Manual." The instruction defines both the events required and their frequency. Table 8 summarizes the 2E6 ACM events required.

TABLE 8. FLEET SQUADRON 2E6 TRAINING EVENTS

<u>EVENT</u>	<u>TITLE</u>	<u>2E6 MODE</u>
ACM I	1 v 1 (two periods)	Optional
ACM II	1 v 2 (two periods)	Integrated
ACM III	2 v 1 (two periods)	Integrated

Event III requires an IP at the console (in addition to the MO).

Manning Summary. The Mission Operator has become the primary operator of the trainer in support of the IP in ACM training for all of the users. He also conducts the routine fleet squadron training events. The Readiness Training squadrons generally provide an IP (or Instructor RIO) at the console to evaluate performance and to fly the manual target/aircraft when desired. All users man the cockpit with aircrews, i.e., both a pilot and an RIO. Although the syllabi indicate that the integrated mode is utilized for the majority of the training events, most of the training observed during the study utilized the independent mode. One of the trainers was generally "down," either for modification or for maintenance. The debrief capability was not observed since it was "down" during the period of the survey.

MODE UTILIZATION. As reviewed in the Introduction, the 2E6 has four primary modes and three submodes of operation. The primary modes are:

- a. Train (TNG),
- b. Plan (PLAN),
- c. Demonstration (DEMO),
- d. Instructor/Operator Training (IP/TNG).

The first three modes, i.e., train, plan, and demonstration are used by the Readiness Squadrons although all of the planned demonstrations have not been developed. The Fleet Squadrons do not utilize the demonstration mode in training. The primary user of the plan mode is the MO.

The instructor/operator training mode is seldom used. It no longer meets the needs of either the squadron instructors or of the professional MO as designed. The instructors do not now require the extensive operating training for which the module was designed. The MOs are already qualified and proficient in the operation of the console, and at the most, might require limited advanced refresher training. The module does not provide the training required by the squadron instructors in the use of the console to monitor aircrew performance or to manually fly the target (or friendly aircraft) or to fly a target/aircraft from one of the domes. Although much of this information is in the

training module, it is not condensed nor in a format which can be readily used by the instructors.

The three submodes provided by the trainer are:

a. Integrated-Independent Mode - provide for operation of the two domes (and cockpits) as separate training devices, each with its own IOS, or for linking them together and operating the entire device as a single trainer from one of the consoles.

Although the majority of training events observed were conducted in the independent mode because of modification and maintenance activities, the syllabi as reviewed earlier, indicate that most of the training will be conducted in the integrated mode if both of the cockpits are "up" and available. An IP will be utilized in one of the trainers for many of the events conducted by the FRSs. The majority of the fleet squadron ACM events will be conducted with two aircrews, one in each trainer.

b. Replay (RPLY) Mode - provides for replay in the dome of up to the last 10 minutes of any event (controls are not simulated). If no specific time is selected, the replay starts at the beginning of the event or at 10 minutes, whichever is shorter. Exit from the mode can be by resetting, by "flying out", by selecting another exercise, or by selecting one of the other primary modes (or standby).

The replay mode was not available during the period of the survey. Questioning of the IPs and MOs indicated little interest in using the feature during routine training.

c. Debrief Mode - provides for selective review of the training session using IOS type CRT displays. Although not a part of the main IOS, the capability is intimately tied to the training operations and is accomplished by the IP (or MO). It provides for the simultaneous and independent replay of the training event utilizing the IOS training display pages. The Debrief Station was not available during the period of the survey. However, the FRSs indicated their intent to utilize it routinely in training.

In addition to the various modes of operation, the trainer has the two features of freeze (FRZE) and reset (RSET). The freeze feature was typically used only if the aircrew experienced serious difficulties or reached a situation in the attack which required analysis and critique. Otherwise the feature was only used to terminate the run. The reset feature is used routinely in setting initial conditions.

Summary. Only two of the primary modes of the trainer were routinely used during the period of the survey, i.e. Train and Plan. The Demonstration mode will probably be utilized more extensively by the FRSs when the required demonstrations have been developed and recorded. The existing instructor/operator

training module will probably not be used since it does not meet the training requirements of the instructors or the MOs. Although most of the observed training was in the independent mode, it appears that the integrated modes will be used extensively when both trainers are available. Similarly, the debrief capability will probably be used when it becomes available. The replay feature was rarely used. Freeze is utilized primarily to terminate a run.

#### BASIC DESIGN DEFICIENCIES

The instructor console was analyzed in terms of two basic design problems, namely:

- a. console layout and arrangement problems,
- b. control and display design and mechanization problems.

Both the console layout and the control/display problems reflect the lack of application of basic human factors engineering during the design of the console as well as the lack of adequate analysis of the training requirement, the user, and the many constraints involved.

The deficiencies will be numbered sequentially with layout problems being identified as "LP-n" and control/display problems as "CDP-n".

LAYOUT DEFICIENCIES. Although the overall console layout was not designed around the professional operator manning concept, the result has proven acceptable and usable for the current mode of operation. However, basic control and display arrangement and layout problems were found. (Refer to Figures 1 and 2.)

LP-1. Poor Console Locations. The orientation of the two consoles in the training area creates several problems. The instructors and operators cannot monitor or observe the dome area since it is located behind them. This also results in the console area being open to most of the traffic to and from the domes. As a consequence, the instructors and operator are normally in the midst of observers and aircrews waiting for training or passing through to the domes. Any visitors are automatically in the instructing and operating area. In addition, light from the high bay area spills onto the console CRT displays. Although not serious with the present lighting, this problem could become acute at higher ambient light levels.

LP-2. Distant Printer Location. The printers which are used to provide the hard copy requested from the IOS are located in the computer spaces one floor below the consoles (and Debriefing Station). As a result, the instructor or operator must either walk down to the computer room to pick up any hard copy desired or have it delivered to him. The problem is further compounded by the fact that the availability of the printer for

hard copy is not indicated at the IOS. The instructor or operator must either walk down to the computer room or request that a technician verify that a printer is "on line" and available for IOS training output.

LP-3. Light Pen Location. The only light pen available on the console is located at the CRT 2 panel. The major user of the pen is the MO at the CRT 3 panel position. Unless the he is left handed, the location of the pen requires that he reach across his primary display to reach the pen.

LP-4. Joystick Location. The joystick is located to the left side of the MO requiring him to reach across the keyboard to operate the control. Although the location does permit use by an instructor at the center panel, the arrangement is not optimum and could result in inadvertent actuation of the keyboard.

LP-5. Intercom Control Locations. Intercom controls are widely separated, one being located at the CRT 1 panel (far left console panel) and the other at the Systems Panel (far right console panel). As a result and because of other intercom problems and confusing operating procedures, the system is normally left in the "all positions" state. There is no back-up system and no means of communicating an emergency in the event of system failure.

CONTROL AND DISPLAY PROBLEMS. Although the control and display requirements of the 2E6 are relatively simple compared to those of a weapons systems trainer, for example, similar problems to those found in the 2F119 and the 2F112 were also found in the 2E6.

CDP-1 Similarity of Indicators and Switches. As found in the other trainers reviewed, a white square electro-mechanical unit is used extensively both for switch and for indicator functions. The units are identical and provide no clue as to whether the function identified by the legend on the surface of the unit can be controlled by pressing the unit, or whether it is only an indicator. For example, the target model (TGT MODEL) units are switches, but the nearby visual system power units are indicators. The breathing air "ON/LOW" unit is both a switch and an indicator while system power (PWR) is a switch and "ALARM" is an indicator.

CDP-2. Non-standard Indicator Color Coding. Color coding of indicators and switches is inconsistent and not in accordance with standards or Navy practice. Unfortunately, the trainer specification (NTEC 2222-1139) and MIL STD-1472 "Human Engineering Criteria for Military Systems, Equipment and Facilities" compound the problem by being in disagreement on some usage of color. The specification calls for amber to be used for color coding of instructor input actions while the MIL STD (and Navy aircrew station design practice) calls for its use in alerting the operator to marginal conditions, the so-called "CAUTION"

light. Similarly, the specification calls for green for "trainee actions", while the MIL STD specifies green for a "GO" condition. Although the trainer color coding is in general agreement with the trainer specification, inconsistencies also exist. For example five of the nine training mode switches used by the operator are yellow in color, the remaining four are white. All of the other instructor input switches such as display selection and print selection are white. The master power switch shows red when selected, a required normal state. Red should be reserved for warning indications.

CDP-3. Inconsistent and Misleading Labeling. The trainer "OCV" switches labeled "1," "2," and "IP/TGT," control different displays depending on the mode of operation and the console being used. The trainer flight instrument selection switches present a similar problem. The "ACM CONTROL" switches on CRT panel 2 are not for ACM "control," but for ACM display purposes. The handrail "FOLD ORID" unit is half indicator and half switch which when pushed, either extends the rails or prevents them from being folded. "COPY FLAG" is an event marker and has nothing to do with copy. Half of the buttons on the function keyboard have function labels, the rest bear only alpha-numeric codes. The trainer system "IN USE" unit is a switch which turns on the red warning lights at the upper and lower entrances to the dome. Labeling on the "g" controls (System Panel) has no meaning for the instructors or MOs. The inter-cockpit communications switch on the CRT 1 panel is labeled "INTERPLANE" while the master switch on the Systems Panel is labeled "INTEGRATED MODE."

CDP-4. Non-functioning Switches and Indicators. The IOS contains non-functional switches and indicators, some of which are even illuminated as if functional. For example, the breathing air switch and indicator and the hand rail switch and indicator are no longer functional. The "spare" hard copy print switch with no foreseeable use, occupies the prime position among the print switches. The maintenance "TEST" switch should not be utilized by the instructor or MO, yet occupies prime space on the Systems Panel.

CDP-5. Inadequate Switch Illumination. Although the general lighting existing in the console area at the time of the survey was adequate to read unlit switch (and indicator) legends, any further reduction of the ambient lighting would result in difficulty in identifying unactivated switches.

CDP-6. Unnecessary Controls. The computer keyboard is not utilized during the Train or the Plan mode as currently mechanized and utilized. Yet the keyboard occupies prime counter space in front of CRT 3. The probability of inadvertent input exists since almost all other control actions require reaching across the keyboard.

CDP-7. Oversimplification of Display Content. While the

other trainers surveyed generally incorporated display pages with an excess of data on each (resulting in readability problems as well as utilization difficulties), many of the display pages on the 2E6 consist of a single data item. This results in cumbersome and time consuming procedures. For example, Training Mode - Mode Select (Figure 16) and Demo Mode Select (Figure 17) each contain a single data element. Although the display pages advance automatically following input, each page requires an ENT (enter) action at the minimum.

CDP-8. Confusing Instrument Readout Selection. The "TRNR INSTR" switches at the CRT 2 panel permit selection of the reference aircraft for the aircraft instruments located below the CRT. In the integrated mode, the options are trainer A, trainer B, or the IP/TGT aircraft. In the independent mode at the console for A, "1" selects trainer A, "2" selects PT 2 and IP/TGT selects IP or PT 1 for the instrument display. At the console for trainer B, "1" selects PT 2, "2" selects the trainer, and "IP/TGT" selects IP or PT 1.

CDP-9. Confusing Relative Position Readouts. The relative altitude and bearing indicators are confusing to the user and as a consequence appear to be little used. For example, the relative altitude indicator consists of a fixed altitude scale and two moving pointers. In the integrated mode, pointer "1" indicates the relative altitude of Dome A aircraft and pointer "2" of dome B aircraft relative to the synthetic aircraft (either a PT or the simulated aircraft flown at the IOS). In the independent mode, pointer "1" represents trainer A and pointer "2" represents PT 2 at the IOS for trainer A, while at the IOS for trainer B, pointer "1" represents PT 2 and pointer "2" represents the trainer.

The BDHI is a conventional aircraft instrument. The compass card indicates the heading of the selected aircraft (trainer A, trainer B, IP flown aircraft, PT 1 or PT 2). The bearing needles are only operative when IP/TGT is selected. In the integrated mode, needle "1" indicates the magnetic bearing of trainer A and needle "2" of trainer B from the IP or PT aircraft. In the independent mode at the trainer A IOS, needle "1" indicates the magnetic bearing of trainer A and needle "2" indicates the magnetic bearing of PT 2 from the IP or PT 1 aircraft. At the trainer B IOS, needle "1" indicates the magnetic bearing of PT 2 and needle 2 indicates the magnetic bearing of trainer B from the IP or PT 1 aircraft.

Table 9 outlines the display for relative altitude.



TRAINING MODE  
MODE SELECT

☒ INDEPENDENT  
☐ INTEGRATED  
☐ DEBRIEF TAPE REQUIRED

USE THE LIGHT PEN TO SELECT A DIFFERENT  
TRAINING MODE

PRESS 'RESET' WHEN SELECTION IS COMPLETE

Figure 16. Training mode - mode select page

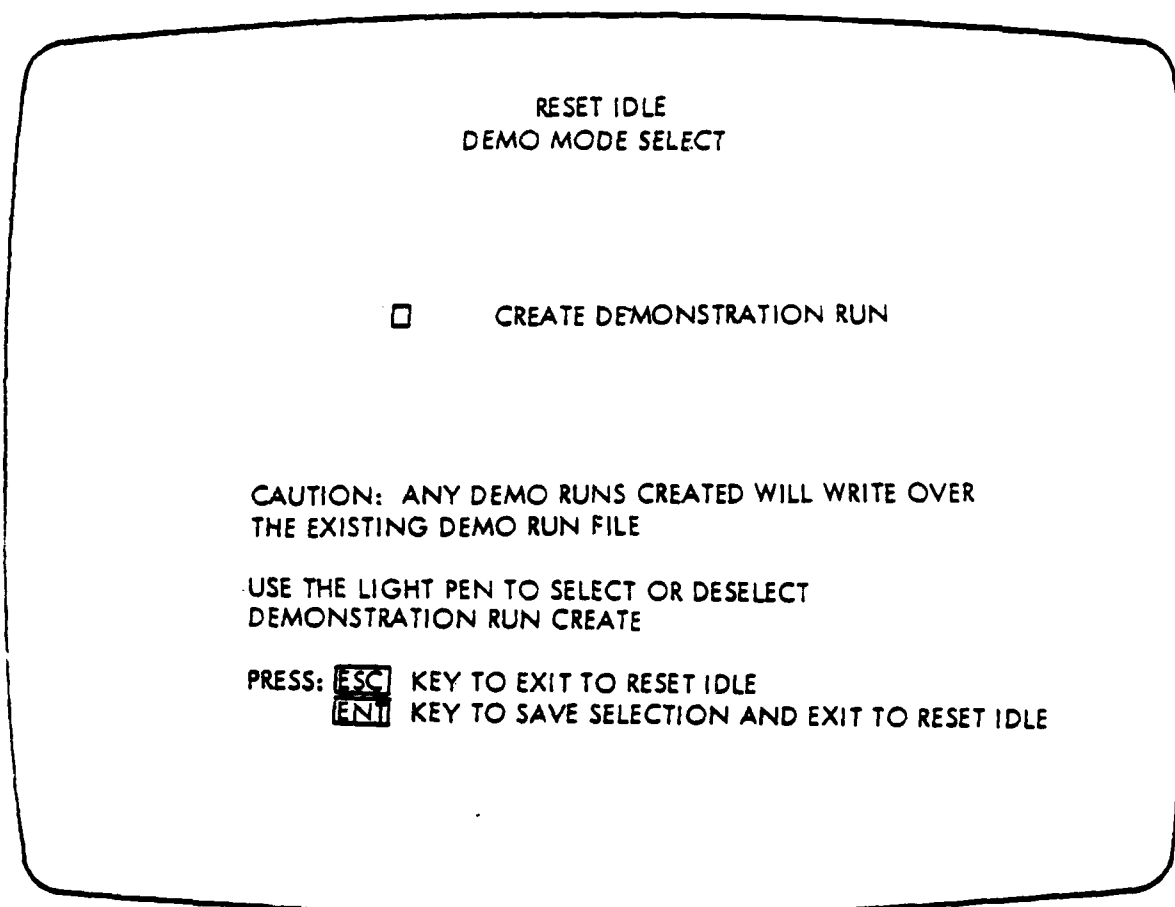


Figure 17. Demo mode select page

TABLE 9. RELATIVE ALTITUDE INDICATIONS

MODE	RELATIVE ALTITUDE		REFERENCE CENTER BAR
	#1 Ptr.	#2 Ptr.	
Console A			
Integrated Mode	Cockpit A	Cockpit B	IP or PT
Independent Mode	Cockpit A	PT 2	IP or PT 1
Console B			
Integrated Mode	Cockpit A	Cockpit B	IP or PT
Independent Mode	PT 2	B Cockpit	IP of PT 1

Table 10 outlines the display options for relative bearing.

TABLE 10. RELATIVE BEARING INDICATIONS

MODE	RELATIVE BEARING		REFERENCE (COMPASS)
	#1 NEEDLE	#2 NEEDLE	
Console A			
Integrated Mode	Cockpit A	Cockpit B	IP or PT
Independent Mode	Cockpit A	PT 2	IP or PT 1
Console B			
Integrated Mode	Cockpit A	Cockpit B	IP or PT
Independent Mode	PT 2	Cockpit B	IP or PT 1

While the indicator logic is consistent, operation in the independent mode should be confusing for the IP.

CDP-10. Switch Activation Inconsistencies. Some switches are used to both activate and deactivate the designated function. Other switches are used to activate a function (and indicate activation) but cannot be used to deactivate it. For some, the reverse is true, i.e., the switch illuminates indicating the function has been activated (from some other location) and can then be deactivated from the illuminated switch. For example, training mode select switches activate (and illuminate) functions but cannot deactivate the function - another mode switch must be activated. Crash override and alarm off switches are used to both activate and deactivate the function.

CDP-11. Control Inconsistencies. Several different types of controls are used to operate the trainer. In some cases, only one control may be used, in others any of several controls can be used. In some cases, the options are made clear; in others, detailed knowledge of the operation is required. For example, the training mode (independent or integrated) must be selected using the light pen only. Most of the display initiated functions can be implemented with either the light pen or a function key although the instructions on the page generally specify "press."

CDP-12. Unnecessary Joystick Trim Wheels. The joystick is equipped with trim wheels for fine adjustment of the joystick input. The controls are not used nor does it appear they are required or will ever be used.

CDP-13. Confusing OCV Selection. The IP/TGT selection for the OCV display has various consequences depending on the mode of trainer operation. In integrated 2 v 1 or in the independent 1 v 1 operation, IP/TGT selects the OCV from the IP/PT aircraft. In independent 2 v 1 training, the switch selects the OCV from IP/PT 1 or PT aircraft. The view switches from one aircraft to the other by repressing the switch. The only real clue to the option implemented exists on the display page itself which identifies the aircraft involved.

CDP-14. Confusing Data Print Format. Figure 18 illustrates the data printout format. As can be seen, the data are printed in scientific notation, a format not utilized in daily flight operations or in routine training. In addition, the printing of parametric flight data at a fixed sample rate is of little value to the IP/IRIO even if they were displayed in a user acceptable format.

CDP-15. Cockpit Trainer Panel Interactions. Although not a part of the IOS, the "TRNR STA" panel (Figure 19) in the cockpits provides override controls for aural cues, buffet, g seat, g suit, and dome lights in addition to an emergency power off switch. There is no indication at the IOS of the positions of these switches. The IP or MO must either visually inspect the panel or request the pilot in the cockpit to report the position of the switches to establish the actual trainer cockpit configuration. A unique problem is also created by the dome light switch which actually changes the existing state of the light when operated. Thus for example, the light may come on when the switch is moved to the "off" position if the switch at the other station has been actuated in the interim.

#### FUNCTIONAL DEFICIENCIES

The training operations of Device 2E6 were analyzed in terms of the same set of training functions utilized in previous studies of IOS designs (see Appendix B). This set consists of the following functions:

- a. prepare - assemble materials, review data, plan event,
- b. brief - review event with student(s) and staff,
- c. initialize - configure trainer, initialize systems, establish readiness,
- d. train - instruct, control simulator, monitor aircrews

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AIR COMBAT MANEUVERING SIMULATOR									
TIME		ALT	PRCH	C	RANGE	RNG RATE	E SUB S	TURN RT	SPEED BK
0.0000E 00	2.0000E 04	0.4187E-01	9.9995E-01	7.1194E 03	3.2153E-02	3.2183E 04	0.0000E 00	0.0000E 00	0.0000E 00
1.0000E 00	2.0000E 04	0.4176E-01	1.0270E 00	7.1203E 03	9.5005E-01	3.2180E 04	0.0000E 00	0.0000E 00	0.0000E 00
2.0000E 00	2.0000E 04	0.4150E-01	1.0230E 00	7.1225E 03	1.6374E 00	3.2175E 04	0.0000E 00	0.0000E 00	0.0000E 00
3.0000E 00	1.9997E 04	0.4157E-01	9.7971E-01	7.1253E 03	1.7003E 00	3.2171E 04	0.0000E 00	0.0000E 00	0.0000E 00
4.0000E 00	1.9983E 04	0.4192E-01	9.4718E-01	7.1281E 03	1.6892E 00	3.2169E 04	0.0000E 00	0.0000E 00	0.0000E 00
5.0000E 00	1.9951E 04	0.4207E-01	9.2194E-01	7.1307E 03	1.4923E 00	3.2164E 04	0.0000E 00	0.0000E 00	0.0000E 00
6.0000E 00	1.9891E 04	0.4465E-01	9.0477E-01	7.1335E 03	1.0005E 00	3.2164E 04	0.0000E 00	0.0000E 00	0.0000E 00
7.0000E 00	1.9795E 04	0.4751E-01	8.9960E-01	7.1369E 03	2.1182E 00	3.2163E 04	0.0000E 00	0.0000E 00	0.0000E 00
8.0000E 00	1.9653E 04	0.5168E-01	9.0055E-01	7.1407E 03	2.4474E 00	3.2157E 04	0.0000E 00	0.0000E 00	0.0000E 00
9.0000E 00	1.9490E 04	0.5733E-01	9.3789E-01	7.1456E 03	3.4151E 00	3.2147E 04	0.0000E 00	0.0000E 00	0.0000E 00
1.0000E 01	1.9284E 04	0.6455E-01	9.9407E-01	7.1526E 03	4.3906E 00	3.2132E 04	0.0000E 00	0.0000E 00	0.0000E 00
1.0000E 01	1.9007E 04	0.7331E-01	1.0038E 00	7.1589E 03	3.8790E 00	3.2110E 04	0.0000E 00	0.0000E 00	0.0000E 00
1.2000E 01	1.8511E 04	0.8296E-01	1.2000E 00	7.1606E 03	-1.2655E 00	3.2078E 04	0.0000E 00	0.0000E 00	0.0000E 00
1.3000E 01	1.8000E 04	0.9254E-01	1.3421E 00	7.1563E 03	-3.1700E 00	3.2034E 04	0.0000E 00	0.0000E 00	0.0000E 00
1.4000E 01	1.7641E 04	9.8223E-01	1.4405E 00	7.1538E 03	1.5452E 00	3.1976E 04	0.0000E 00	0.0000E 00	0.0000E 00
1.5000E 01	1.7180E 04	9.1004E-01	1.5070E 00	7.1669E 03	1.5731E 01	3.1904E 04	0.0000E 00	0.0000E 00	0.0000E 00
1.6000E 01	1.6745E 04	9.1571E-01	1.5123E 00	7.2005E 03	3.2945E 01	3.1820E 04	0.0000E 00	0.0000E 00	0.0000E 00
1.7000E 01	1.6310E 04	9.2021E-01	1.4936E 00	7.2761E 03	4.6460E 01	3.1726E 04	0.0000E 00	0.0000E 00	0.0000E 00
1.8000E 01	1.5070E 04	9.2457E-01	1.4740E 00	7.3614E 03	5.2702E 01	3.1623E 04	0.0000E 00	0.0000E 00	0.0000E 00
1.9000E 01	1.5401E 04	9.2900E-01	1.4030E 00	7.4407E 03	4.9314E 01	3.1504E 04	0.0000E 00	0.0000E 00	0.0000E 00
2.0000E 01	1.4079E 04	9.3372E-01	1.5567E 00	7.5246E 03	4.0301E 01	3.1364E 04	0.0000E 00	0.0000E 00	0.0000E 00

AIR COMBAT MANEUVERING SIMULATOR									
TIME		ANG OFF	SU TIME	SP TIME	GUN TIME	SU HITS	SP HITS	GUN HITS	
0.0000E 00	1.7014E 02	0.0000E 00	0.0000E 00	0.0000E 00	0.0000E 00	0	0	0	
1.0000E 00	1.7020E 02	0.0000E 00	0.0000E 00	0.0000E 00	0.0000E 00	0	0	0	
2.0000E 00	1.7515E 02	0.0000E 00	0.0000E 00	0.0000E 00	0.0000E 00	0	0	0	
3.0000E 00	1.7070E 02	0.0000E 00	0.0000E 00	0.0000E 00	0.0000E 00	0	0	0	
4.0000E 00	1.7600E 02	0.0000E 00	0.0000E 00	0.0700E 00	0.0000E 00	0	0	0	
5.0000E 00	1.7573E 02	0.0000E 00	0.0000E 00	0.0000E 00	0.0000E 00	0	0	0	
6.0000E 00	1.7375E 02	0.0000E 00	0.0000E 00	0.0000E 00	0.0000E 00	0	0	0	
7.0000E 00	1.7141E 02	0.0000E 00	0.0000E 00	0.0000E 00	0.0000E 00	0	0	0	
8.0000E 00	1.6937E 02	0.0000E 00	0.0000E 00	0.0000E 00	0.0000E 00	0	0	0	
9.0000E 00	1.6757E 02	0.0000E 00	0.0000E 00	0.0000E 00	0.0000E 00	0	0	0	
1.0000E 01	1.6717E 02	0.0000E 00	0.0000E 00	0.0000E 00	0.0000E 00	0	0	0	
1.1000E 01	1.6762E 02	0.0000E 00	0.0000E 00	0.0000E 00	0.0000E 00	0	0	0	
1.2000E 01	1.7136E 02	0.0000E 00	0.0000E 00	0.0000E 00	0.0000E 00	0	0	0	
1.3000E 01	1.7575E 02	0.0000E 00	0.0000E 00	0.0000E 00	0.0000E 00	0	0	0	
1.4000E 01	1.7606E 02	0.0000E 00	0.0000E 00	0.0000E 00	0.0000E 00	0	0	0	
1.5000E 01	1.7166E 02	0.0000E 00	0.0000E 00	0.0000E 00	0.0000E 00	0	0	0	
1.6000E 01	1.7150E 02	0.0000E 00	0.0000E 00	0.0000E 00	0.0000E 00	0	0	0	
1.7000E 01	1.6901E 02	0.0000E 00	0.0000E 00	0.0000E 00	0.0000E 00	0	0	0	
1.8000E 01	1.6734E 02	0.0000E 00	0.0000E 00	0.0000E 00	0.0000E 00	0	0	0	
1.9000E 01	1.6949E 02	0.0000E 00	0.0000E 00	0.0000E 00	0.0000E 00	0	0	0	
2.0000E 01	1.7275E 02	0.0000E 00	0.0000E 00	0.0000E 00	0.0000E 00	0	0	0	

Figure 18. Sample debrief data printout

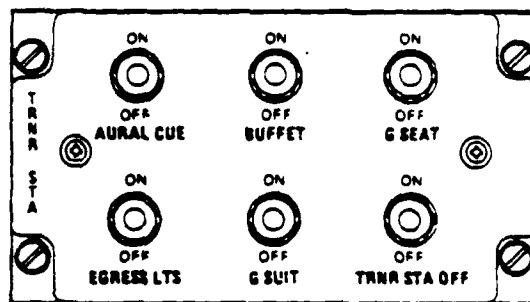


Figure 19. Trainer panel

performance,

e. evaluate - diagnose aircrew problems, evaluate aircrew proficiency,

f. debrief - review training event with aircrew and staff,

g. manage data - update aircrew training data, staff data, device data,

n. develop syllabus/training events,

i. train instructor/operators - train device users in device operation and utilization,

j. student/peer training - provide for student and/or peer self practice.

Trainer operating task and function flow charts were developed to clarify the procedures involved and to permit the identification of problems and deficiencies. Appendix C contains the flow charts developed.

Standard flow chart symbols were adapted to these analyses. The key to symbols utilized in the flow charts is as follows.

#### Flowchart Symbol Key

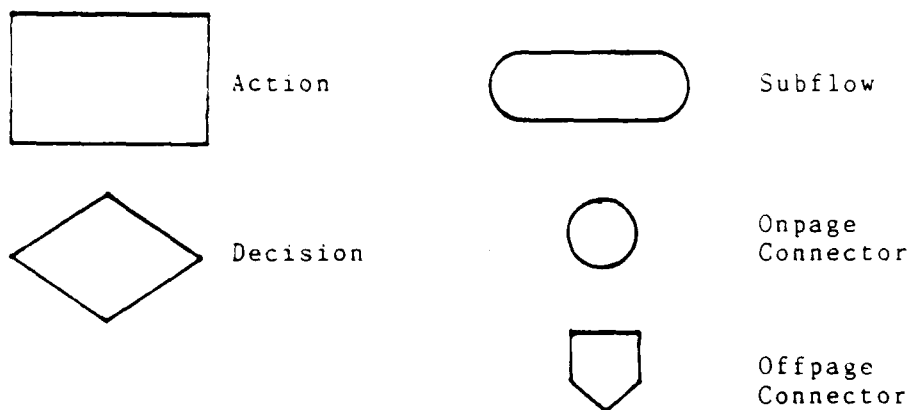


Figure 20 is a flowchart of the modes of operation of the trainer. As can be seen, these modes do not directly relate to the functions outlined above. For example, the train function includes some of the features contained in the Train Mode, the Demo Mode, Plan Mode, and the Debrief Mode and vice versa, not all of the features in the Train Mode are included in the Train Function. The support which the trainer modes could conceivably

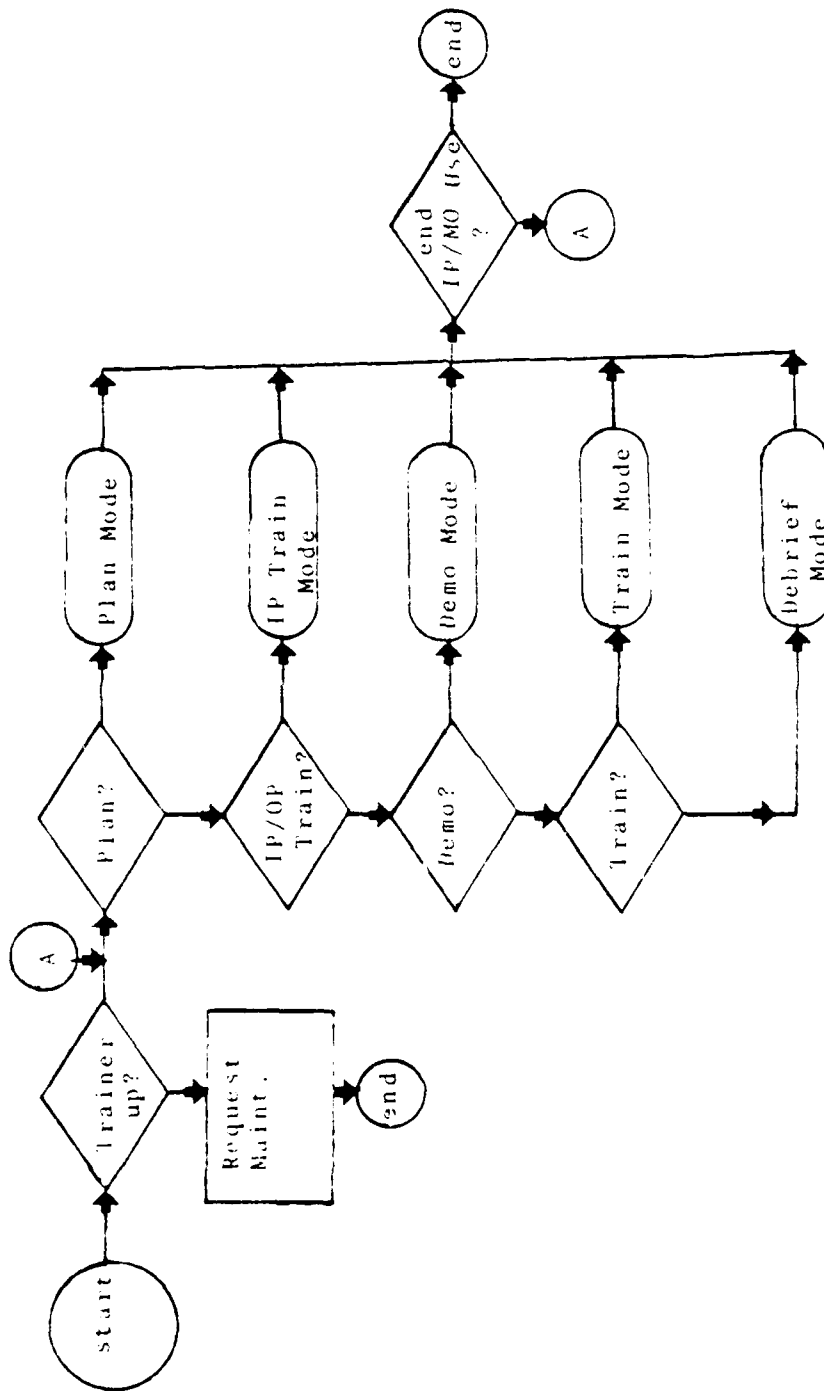


Figure 20. Mode flow chart of 2E6.



provide to the training functions is in general as follows:

- (1) Plan Mode - Briefing Function: briefing of staff on ICs,  
 - Initialize Function: modify ICs  
 - Develop Syllabus/Training Events Function:  
 preprogram ICs,
- (2) Train Mode - Briefing Function: briefing of staff on ICs,  
 - Initialize Function: system initializing,  
 - Train Function: all simulation training,  
 - Evaluate Function: data printouts,  
 - Develop Syllabus/Training Events Function:  
 develop demonstrations,
- (3) Demo Mode - Train Function: run demonstrations,
- (4) IP Train Mode - Train Instructor/operator Function: train  
 in console operation.  
 - Student/Peer Training Function - train in  
 console operation.

The Debrief Facility, while not a mode of the trainer, supports the debrief function and could support the brief function.

Many problems and deficiencies relative to the training functions were found in the 2E6. They are listed numerically as FD-"n" below.

PREPARE FUNCTION. Training Device 2E6 does not support the prepare function. Syllabi, lesson guides, instructor guides, scenarios, schedules and training records are not stored in the 2E6 system.

FD-1. Limited Preparation Data Availability. Access to any of the IC data relative to syllabus events is limited. No useful summary of a programmed event is directly available. The Problem Summary page shown in Figure 21, contains minimum data on the event itself, but extensive data on parameter recording which is seldom utilized. For example, it does not include any data on the IC in terms of altitudes, speeds, headings or ranges. Except for the IC number, which is not event unique, the user has no information or clue as to what the event related IC consists of or its relation to the syllabus. No information on prerequisite knowledge or skill are provided. No data on what the briefing should consist of are provided. No data on scenario options or adaptive changes possible or suggested are available. No aircrew history or background data are available.

BRIEF FUNCTION. Device 2E6 does not directly support the brief function, for the aircrew or the training staff.

FD-2. Minimal Aircrew Briefing Data. Although the Debrief station could potentially be utilized to support the briefing function, no plans exist to implement such usage. Similarly, the

INDEPENDENT MODE PROBLEM SUMMARY					
AIRCRAFT PARAMETERS			CRASH CONDITIONS		
	TR1	PT		TR1	PT
TYPE	F-4J	F-14A	ALT	<del>100</del>	<del>100</del>
MSL	<del>4SP0SW</del>	<del>4SP0SW</del>		<del>50000</del>	<del>50000</del>
GUN		<del>630</del>	G	<del>-3.0</del>	<del>-3.0</del>
GR WT	<del>46980</del>	59694		<del>10.0</del>	<del>10.0</del>
FUEL	<del>9300</del>	<del>16200</del>	RNG	<del>50FT</del>	<del>50FT</del>
				<del>10NM</del>	<del>10NM</del>
TOLERANCE PARAMETERS					
	TR1	PT		PT	
ALT	<del>500</del>	<del>40000</del>	<del>500</del>	<del>40000</del>	
KIAS	<del>250</del>	<del>750</del>	<del>250</del>	<del>750</del>	
MACH	<del>0.3</del>	<del>1.4</del>	<del>0.3</del>	<del>1.4</del>	
AOA	<del>-10</del>	<del>30</del>	<del>-10</del>	<del>30</del>	
G	<del>-2.0</del>	<del>6.5</del>	<del>-2.0</del>	<del>6.5</del>	
VV	<del>-60000</del>	<del>60000</del>	<del>-60000</del>	<del>60000</del>	
RANGE	<del>100 FT</del>	<del>10 NM</del>	<del>100 FT</del>	<del>10 NM</del>	
SIDESLIP	<del>-10</del>	<del>10</del>	<del>-10</del>	<del>10</del>	
RECORDING PARAMETERS					
TR1			PT		
ALTITUDE	KIAS		ALTITUDE	KIAS	
MACH	AOA		MACH	AOA	
G	VV		G	VV	
RANGE	RNG RATE		RANGE	RNG RT	
SIDESLIP	HEADING		SIDESLIP	HEADING	
ROLL ANG	YAW RATE		ROLL ANG	YAW RATE	
PITCH RT	ROLL RT		PITCH RT	ROLL RT	
P SUB S			P SUB S		

Figure 21. Independent mode problem summary

demonstration mode could be utilized in briefings. However, the capability of creating a demonstration is not directly oriented to briefing requirements although it appears that few changes would be required to adapt it to this purpose.

FD-3. Minimal Training Staff Briefing Data. Unless the Plan Mode data are accessed, little information is available to the MO and IP to review the scheduled event or the upcoming run (unless the MO recalls the details of the IC or has written the data on a piece of paper). ICs bear no informative title nor is the syllabus directly tied to IC numbers. It is anticipated that as the syllabus details are developed through usage of the trainer, more definitive data on the ICs for the training events will be created. If means are found to store these data, it could then be used for briefing and planning the execution of the event.

INITIALIZE FUNCTION. The initialize function includes configuring the simulator, initializing the simulation and training programs and establishing readiness for training. The function is in large, performed by the MO for the 2E6. Although the MOs have learned to initialize the trainer, the procedures required are far from optimum and have led to the creation of "customized" shortcuts and "make-do" procedures. As will be pointed out in the following sections, the poorly designed documentation compounds the problem.

The initialize function was analyzed in detail using the task flow chart approach. Figure 22 depicts the flow as described in the operator's handbook. Appendix A contains the detailed function and task flow charts for the initialize function.

Many of the initialization problems found are unique to the 2E6 (compared to those found in the earlier reviews of WSTs). This results both from the part mission training function involved and from the characteristics of the interface implemented in the console design. For example, the "query-answer" CRT initialization page design, while minimizing operator training and possibly errors, results in a serious lack of information on the overall event objectives and the state of the initialization process at any specific point in the process. In some areas of initialization for example, the only source of detailed information requires accessing the Plan Mode.

Console and Cockpit Initialization Tasks. The first two initialization tasks as shown in Figure 22, are concerned with configuring the consoles and the cockpit for training. Both are concerned with establishing a standard configuration prior to initializing the specifics of a syllabus event. While the cockpit as hardware, is not a part of the IOS, the position of many of the controls in the cockpit is a functional part of the IOS. The position of the switches on the trainer panel for example, interact with the systems panel controls. Although

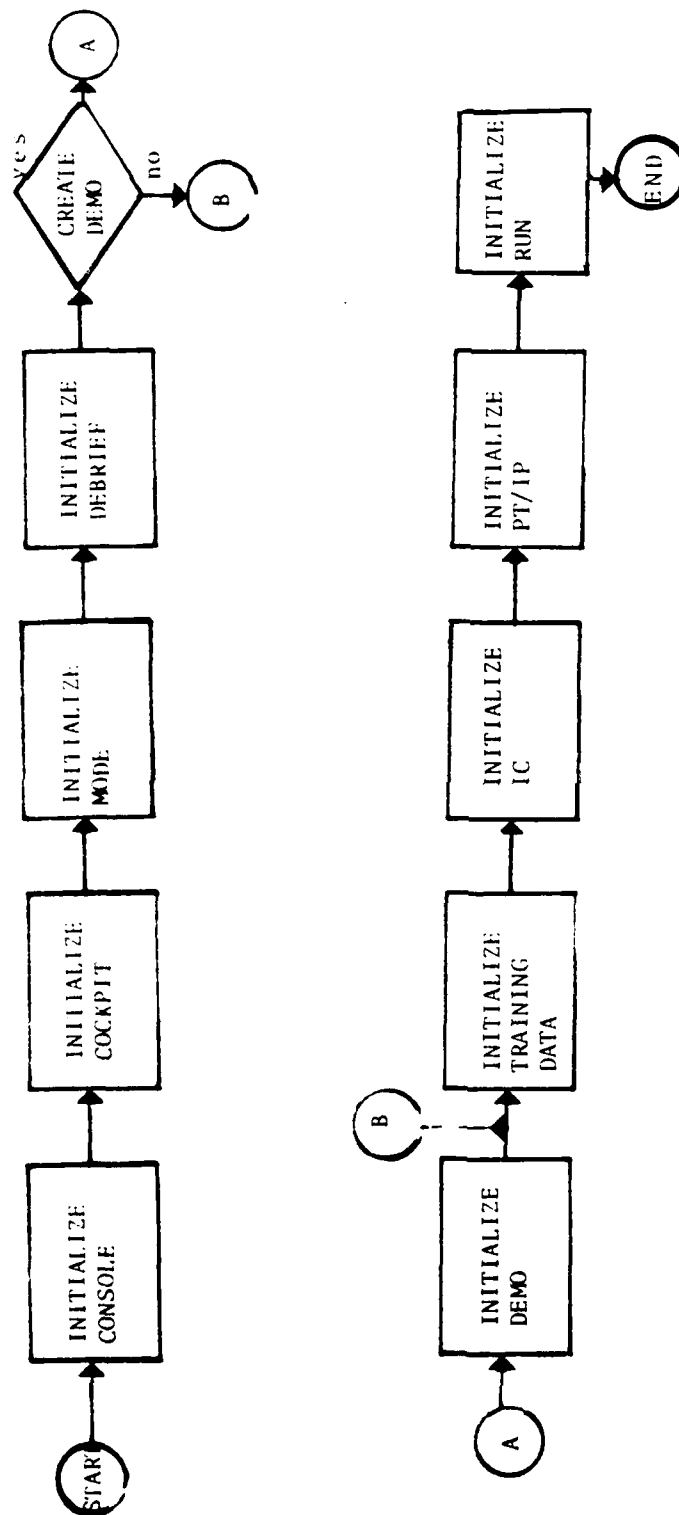


Figure 22. Initialize task flow

cockpit checks are not routinely made, they are considered as part of the initialization procedures.

The IOS configuration checks include setting communications switches, adjusting intensity and focus of the CRTs, selecting trainer instrument displays, setting ACM display controls, checking for correct model, and setting g and buffet simulation levels, missile tones, and override switches.

Among the problems involved in initializing the configuration are the following:

FD-4. Unutilized Special Features. The following controls or features are in effect, superfluous to trainer operation since the capabilities are not utilized. They include:

- a. wing trace control (ACM display),
- b. ACM display zoom controls,
- c. g suit, g seat, and g dimming controls (g suits were not worn during training at the time of the survey),
- d. breathing air controls (oxygen masks are not worn during training),
- e. hand rail controls (the rear platform rails have been modified and are no longer folded for training),
- f. missile tones.

The controls cannot be ignored since the effects or features are not incorporated in the preprogrammable IC. Thus they must form part of the initialization check to ensure that their inputs during the training event are as required.

FD-5. Manual Operation of Dome Warning Lights. Since the domes do not contain a motion platform, the need for the warning lights (red "in-use" light) is considered by the users to be of minor importance to the operation of the device. Consequently, they are not regularly turned on. This inconsistent use of red warning lights is undesirable. Either the lights should be used or if not required, they should be removed. (Activation of the light could be automated, e.g., tied to turn off of the dome lights or activation of the mode switches).

FD-6. Forward Platform Folding-Rail Hazard. The forward platform guard rails in the dome are folded only if specifically requested by the aircrew. This results from two design features. First, the fold procedure is time consuming and requires additional personnel. Secondly, the folded rails create a potential safety hazard for the aircrew when egressing from the cockpit. However, the inconsistent policy (folding only on request) would appear to present an even greater safety problem.

The folding and unfolding procedure involves interlocking manual switches at the platform and at the lower deck level of the dome. To operate them, the MO must call a technician via the ICS system to enter the lower level of the dome and standby to fold the rails. Then the MO must go to the upper level of the dome, establish voice communications with the technician below, and then both must simultaneously activate the fold switches at each level. There is no emergency unfold control, either at the IOS or in the cockpit. There is no indication to the aircrew as to the state of the rails other than by visually inspecting the rails.

Mode Initialization. Mode initialization (independent or integrated operation) will be discussed with IC initialization to which it is closely tied.

Debrief Initialization. The debrief initialization involves interlocks and design features which should prove frustrating when the debrief capability is operational.

FD-7. Complex and Time Consuming Initialization of the Debriefing Feature. Since the debrief capability was not available during the survey, the procedures analyzed reflect the information in the operator's handbook and discussions with operators and technicians. Recording for debriefing is accomplished on tape. Therefore a tape must be loaded and must have adequate record time remaining. Debrief must be selected on the first display which appears on starting initialization of the trainer - the Mode Select page. If debrief is selected and a tape is loaded and ready, the "XFR RDY" light will appear on the CRT 3 console. However if the light does not come on, no further initialization actions are possible and the problem must be resolved (or the debrief requirement cancelled). This requires contacting a technician in the computer area to complete the tape loading process. When the "XFR RDY" light comes on, the recording mode, manual or automatic, can then be selected. However, even if the automatic mode is selected, a display page will appear at the end of the run requiring verification of the automated record mode before recording will be effective.

Initialize Demo. The initialization of a demonstration while simple, can present serious problems. As with IC initialization, (the next task), the major problem involves lack of information.

FD-8. Lack of Information for Demonstration Selection. When Demo Mode is selected, the Demonstration Mode Run Selection page (Figure 23) is automatically displayed. As can be seen, demonstration selection is by number. No titles and no clues as to what the run involves are provided. Thus the instructor or operator has no idea what number to select for the demonstration desired unless he has notes as to which demonstrations have been assigned which run numbers. There is no index. The problem can be further compounded if the relevant set of demonstrations are

DEMONSTRATION MODE  
RUN SELECTION

THE DEMO MODE DISC FILE CONTAINS THE FOLLOWING RUNS  
RUN NUMBERS

☐ 1 ☐ 2 ☒ 3 ☐ 4 ☐ 5

RUN 3 SELECTED

USE LIGHT PEN TO SELECT RUN FOR DEMO

PRESS: ☐ ENT KEY WHEN SELECTION IS MADE

Figure 23. Demonstration mode run selection page

not loaded on the system. Thus even if the proper number is selected, the desired demonstration will not be initialized.

When the demonstration number has been entered, the Demonstration Mode Initialization display page (Figure 24) appears. Again, as can be seen, little useful descriptive data on the demonstration are presented. The page is furthermore displayed on CRT 3 in front of the MO rather than front of the IP/IRIO who would use the information.

Initialize the IC. The IC initialization task is unique because of the restricted simulation environment involved and because of the part mission nature of the training. However the procedure as implemented presents several problems. In general, problems arise because all of the ICs are partially programmed and partially manually implemented.

FD-9. Complex Initializing of Preprogrammed IC. A preprogrammed IC cannot be accessed without, in effect, selecting the mode of training and entering an IC number. On activating the training mode (TNG), the first display which appears is the mode select option (see Figure 16). The MO or IP will know the mode to be utilized for the training event. Thus this selection can be made without accessing the preprogrammed IC although the programmed IC contains the mode as part of the stored IC data.

When reset is activated after selecting the mode, the Problem Summary page appears on CRT 2 and the Reset Idle page on CRT 3. The problem summary reflects the last IC utilized or initiated by the maintenance crew. The IC number is displayed on the Reset Idle page. Unless the MO or IP know the number of the stored IC desired (there is no meaningful index), the 16 optional ICs must be called and individually reviewed to identify the one sought. The alternative is to exit to the Plan Mode and create an IC. Since the problem summary display does not contain definitive data on the IC, the IC Summary page must be called (overlying the other summary page on CRT 2) for each of the ICs to be reviewed. This is time consuming and can be further complicated by the possibility that the IC desired may not even exist in the data loaded into the computer.

FD-10. Performance Data Summary Initialization Complexity. As will be discussed under the evaluation function, the End of Engagement Summary print out (Figure 25) is rarely utilized. The data has proven of little value in the form available. The initialization procedure is time consuming and complex. Although it can be preprogrammed, the individual instructor would probably edit the data to be collected at the start of the event (and even during training) based on his instructing techniques and the aircrew's problems. The means of implementing the option is complex and requires entering the Plan Mode and identifying up to 14 parameters on the Parameter Record page (Figure 26) and then entering the tolerance levels on the Tolerance Parameters page (Figure 27) for each of the aircraft of interest.



DEMONSTRATION MODE  
INITIALIZATION

RUN NO. 3                  DEMO MODE                  RUN DATE 04/15/79                  IC NUMBER 1

TR:                          TR2                          IP

TYPE                          F-14A                          F-14A

PILOT:                  LT W.T. DOOR

NFO:                          LTJG R.W. ROE

INSTRUCTOR: LCDR W.I. NOBODSKI

COPY FLAGS:

TIME	COMMENT	TIME	COMMENT	TIME	COMMENT
35.4	TR2 FIRE 7F				
43.6	TR2 FIRE 7F				
48.9	TR2 FIRE 9L				
51.2	IP FIRE 7F				
63.7	IP FIRE 9L				

ENTER INITIALIZATION TIME IN SECONDS:                  RUN TIME       

PRESS:  KEY TO EXIT TO DEMO RUN SELECTION

KEY TO INITIALIZE DEMO

Figure 24. Demonstration mode initialization page

# NAVTRAEQUIPCEN 82-M-0767-1

04/10/79	14:09:02	PCMS	SYSTEMS REAL-TIME MONITOR-5.2 CPU A		PAGE 1
RUN 6	04/10/79		14:09:01		PAGE NO 1
TOLERANCE PARAMETERS EXCEEDED BY TR:					
PARAMETER	START TIME	END TIME			
KIAS	6	8			
G	51	56			
NO TOLERANCE PARAMETERS WERE EXCEEDED BY PT					

04/10/79	14:09:02	PCMS	SYSTEMS REAL-TIME MONITOR-5.2 CPU A		PAGE 2
END OF ENGAGEMENT SUMMARY					
RUN NUMBER 6	DATE OF RUN 04/10/79	TIME OF RUN 14:09:01	IC NUMBER 15		
TR:	TR1	PT			
TYPE:	F-4J	THRT2			
ARM:	4SP/4SL	250/25L/558GN			
PILOT:	LT U.T. DOOR				
WFO:	LT R.V. ROE				
INSTRUCTOR: LCDR M.I. KOBODSKI					
== TR1 SHOTS ==					
NO GUN RND5 FIRED					
NO MISSILES LAUNCHED					
== PT SHOTS ==					
GUN BURST:	TIME	10' HITS	20' HITS		
	33.7	0	0		
	34.9	0	0		
	43.1	0	10		
	46.1	0	0		
	56.4	0	36		
	70.7	0	0		
550 RND5 FIRED	TOTALS:	0	54		
MISSILES:	TYPE	TIME	TGT	KILL	REASON
	AIM7F	9.5	TR1	YES	2107.0 0A 1. 6. 1.2 10073. 486.
	AIM7F	136.3	TR1	YES	1.3M -122. 5. 2 1.1 9654. 341.
	AIM9L	109.7	?	NO	L01
	AIM9L	114.0	TR1	YES	0.7M -77. 10. 3. 1.2 8775. 376.

Figure 25. Sample end of engagement printout

PARAMETER RECORDING  
TRI

<input checked="" type="checkbox"/> ALTITUDE	<input checked="" type="checkbox"/> HEADING	<input type="checkbox"/> THROTTLE
<input checked="" type="checkbox"/> KIAS	<input checked="" type="checkbox"/> ROLL ANG	<input type="checkbox"/> FLAP POS
<input checked="" type="checkbox"/> MACH	<input type="checkbox"/> YAW RATE	<input type="checkbox"/> ANG OFF
<input checked="" type="checkbox"/> AOA	<input checked="" type="checkbox"/> PITCH RT	<input type="checkbox"/> SRM TIME
<input checked="" type="checkbox"/> G	<input checked="" type="checkbox"/> ROLL RT	<input type="checkbox"/> MRM TIME
<input checked="" type="checkbox"/> VV	<input checked="" type="checkbox"/> P SUB S	<input type="checkbox"/> GUN TIME
<input type="checkbox"/> RANGE	<input checked="" type="checkbox"/> E SUB S	<input type="checkbox"/> SRM HITS
<input type="checkbox"/> RNG RATE	<input checked="" type="checkbox"/> TURN RT	<input type="checkbox"/> MRM HITS
<input type="checkbox"/> SIDESLIP	<input checked="" type="checkbox"/> SPEED BK	<input type="checkbox"/> GUN HITS

14 PARAMETERS SELECTED

USE THE LIGHT PEN TO SELECT AIRCRAFT  
AND PARAMETERS (15 MAX)

PRESS: **ESC** KEY TO EXIT TO PLAN MODE INITIALIZATION  
**ENT** KEY TO SAVE DATA

Figure 26. Parameter recording page

TOLERANCE PARAMETERS							
		TR1		TR2		PT	
<input type="checkbox"/> ALTITUDE	FT-	0	0	100	50000	100	5000
<input type="checkbox"/> IAS	KTS-	150	950	150	950	150	950
<input type="checkbox"/> MACH	-	0.28	1.40	0.28	1.40	0.28	1.40
<input checked="" type="checkbox"/> AOA	UNITS-	-10	40	-10	40	-18	40
<input type="checkbox"/> G	-	-3.0	10.0	-3.0	10.0	-3.8	10.0
<input type="checkbox"/> VV	FPM-	-1000	5000	-1000	5000	-1000	5000
<input type="checkbox"/> RANGE FT/NM-		50	50000	50	50000	50	50000
<input type="checkbox"/> SIDESLIP DEG-		-8.0	8	-8.0	8	-8.0	8

☐ TR1  
☐ TR2  
☒ PT

ENTER DATA: \_\_\_\_\_

USE LIGHT PEN TO SELECT TOLERANCE  
 PARAMETER AND AIRCRAFT FOR DATA.  
 USE KEYBOARD TO ENTER DATA.  
 USE LIGHT PEN TO STORE DATA. BLANK ENTRIES ARE IGNORED.      ° STORE DATA

PRESS: **ESC** KEY TO EXIT TO PLAN MODE INITIALIZATION  
**ENT** KEY TO SAVE DATA AND EXIT TO CRASH CONDITIONS

Figure 27. Tolerance parameters page

Crew Data Initialization. The system was designed to utilize crew weights and names. However, the feature has not proven useful or necessary as the trainer is currently implemented.

FD-11. Crew Data Not Initialized. Figure 28 depicts the crew data entry display page. These data are apparently never entered nor are they essential to the training event. The name for example, is only used as header information for data printout which was not used during the survey. It is doubtful if the printout will ever be utilized as will be discussed in following paragraphs. The weight and g gradient data are not utilized since g suits are not worn. Even if they are worn, a fixed g simulation program will probably be utilized.

IP/Pt Level Initialization. The programmed target skill level and the g limits for the manually flown target must be manually set as part of the IC initialization.

FD-12. Manual IP/PT Level Set. The programmed target "difficulty" or skill level and the IP g limit are not included as part of the programmed IC. As implemented, the conditions must be set using a display page (Figure 29) which describes the level involved or by using the function keys: A-1, A-2, or A-3 (level 4 is set by deselecting all three!) which have little meaning to the instructor.

TRAIN FUNCTION. The train function includes all the tasks from the activation of the simulation program until its deactivation at the end of the training session. It includes some of the features in the Train Mode of the 2E6 as well as some of those in the Plan and Demo Modes. Figure 30 summarizes the tasks in a flow chart as implemented in the 2E6. The next level task flow charts are contained in Appendix C. Most of the problems or deficiencies in the train function reflect the control and display deficiencies. These include for example, the difficulty in manual flying of the target/aircraft because of the limited flight and system information. Other examples include the initialization problems which can reoccur during training with IP/PT level changes, refueling/rearming, data parameter print selection, demo initialize, and new IC initializing. The additional problems reflect both layout and procedural deficiencies.

FD-13. Training Controls Remote From Instructor. The master training controls are located on CRT 3 panel. Thus the IP or IRIO must either request the MO to take the desired action or reach across to activate the feature desired. This includes the basic training features of freeze, operate, reset, and replay.

FD-14. Manual Simulation of Communications. As in the other trainers surveyed, all simulation of communications, both background and control/tactical, must be performed by the

RESET IDLE  
TRAINEE DATA

ENTER CREW MEMBERS' NAMES

☒ TR2: PILOT LT W.T. DOOR  
 NFO LT R.W. ROE

☐ IP: LCDR W. J. NOBODSKI

ENTER CREW MEMBERS' WEIGHTS

☐ TR2: PILOT 175  
 NFO 165

SELECT G-SUIT  
GRADIENT (PSI/G)

<input type="checkbox"/>	0.125
<input type="checkbox"/>	0.250
<input type="checkbox"/>	0.375
<input checked="" type="checkbox"/>	0.500

☐ STORE DATA

DATA:

PRESS: **ESC** KEY TO EXIT TO RESET IDLE  
**ENT** KEY TO SAVE ENTRIES AND EXIT TO RESET IDLE

Figure 28. Trainee data page

TRAINING MODE  
PT LEVEL AND IP  
FLIGHT LIMIT

- ☐ LEVEL 1 - STRAIGHT AND LEVEL
- ☐ LEVEL 2 - VARIABLE G-LEVEL 'S' TURNS
- ☐ LEVEL 3 - DEGRADED PILOT REACTION TIME
- ☒ LEVEL 4 - NORMAL PILOT REACTION TIME

REVERSAL TIME: 28.0  
G LEVEL: 3.0  
FLIGHT LIMIT: 8.0 ^

USE THE LIGHT PEN TO SELECT THE PT LEVEL.  
FOR PT LEVEL 2, USE THE KEYBOARD TO ENTER  
THE REVERSAL TIME AND G LEVEL. FOR THE IP,  
ENTER THE FLIGHT LIMIT.

PRESS: **[ESC]** KEY TO EXIT TO RESET IDLE  
**[ENT]** KEY TO SAVE ENTRIES AND EXIT TO RESET IDLE

Figure 29. PT level and IP flight limit page

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instructors or the MOs. This not only interferes with monitoring of aircrew performance but will become impossible in the integrated mode with the instructor also trying to fly a target/ aircraft from the console.

FD-15. Display/Control Limitations of CRT 1 and 2. All of the display pages involved in the control of the simulation as well as the controls required (light pen and FKB) are located at the CRT 3 station. Thus the IP/IRIO must request that the MO implement the actions desired. This not only delays and discourages use of the training control options but delays inputs, leads to errors and interferes with MO activities.

EVALUATE FUNCTION. The evaluate function is concerned with performance appraisal as opposed to performance monitoring, which is included in the train function. Therefore performance is evaluated relative to training criteria and decisions made as to the training strategy to employ and to achieve the performance required. The 2E6 does not effectively support this function although efforts are underway to develop and implement a performance measurement system.

FD-16. Run Summary Unuseable. The End of Engagement Summary is not useful in evaluation since the data are not summarized and are not related to training criteria or the specific training event objectives. To compound the problem, even if the data were in a useful format, they are not available in a usable time frame to the instructors at the console, since they are printed in the computer spaces one floor below the instructor console area.

FD-17. Data Print Ineffective. The printout of data during debrief also appears to be unuseable for performance evaluation or instructing purposes. The data are not summarized, cannot be directly related to run events and flags, and are presented in scientific notation. Although the print interval can be selected, the start time is the start of the run and all of the selected flight parameters are printed at the selected sample time for the entire run. Finally, the data are printed in the computer spaces and thus are not directly available at the debriefing facility. Printer availability problems can be expected to cause further problems.

DEBRIEF FUNCTION. The 2E6 is the only trainer surveyed which was designed with an independent and simultaneous debriefing capability, i.e., the debriefing can be conducted without interfering with simulator training and can present data directly from the training event for debriefing. The Debrief Facility was not available during the period of the survey so the analysis of its characteristics and operations is based on technical reports and discussions with personnel who had utilized the facility or observed its use. The facility utilizes the same displays and relevant display pages used at the instructor console. Similar problems, therefore, exist in terms of the display-control mechanization (already reviewed). The printout problems are

similar in that the printer is located in the computer spaces one floor below the facility. The unique problems reflect the mechanization (tape recordings) and the difficulty of accessing any specific point in the replay.

FD-18. Debrief Initialization Complexity. The debrief capability utilizes data recorded on magnetic tape during training. It is replayed on an independent computer system and therefore requires that the tape be physically identified, loaded onto the debriefing system and transferred unto the disc for debrief replay. The result is similar to the problem of initializing the record for debrief in that debriefing cannot take place unless the technicians in the computer spaces can be directed to complete the transfer and loading of the correct magnetic tape. Only one debrief facility exists but two debrief tapes can exist in the independent mode.

FD-19. Replay Initialization Difficulty. The replay can be readily initialized to the start of the recording or to a flag set during training. However, in general, a replay for critique or even demonstration should be initialized to the precipitating conditions or events. Typically this is at least 5 to 10 seconds before the consequences are observable and a flag settable. Unless the actual mission or event time can be estimated and entered, there is no way at the debrief facility of resetting the replay to this criteria. As a result, replay cannot be effectively used. The required modification is state-of-the-art.

FD-20. Debrief Facility Physical Limitations. The Debrief Facility is located in a classroom and consists of the console outlined in Figure 12. No specific seating arrangements (or chairs) have been provided for the debriefing. Since only two displays are available (and an instructor must be seated at the right CRT), locations and seating for debriefing at the console could present a problem, especially for integrated missions where two aircrews and two or three instructors could be involved. Overhead lighting could present a problem in terms of display reflections and display readability.

DEBRIEF DATA FUNCTION. The 2E6 does not support the data management function either in terms of student and instructor data or in terms of device training utilization.

SCENARIO DEVELOPMENT FUNCTION. The Plan Mode of the 2E6 supports the scenario development function in terms of preprogramming ICs. It supports the preprogramming of some, but not all of the parameters required for the initial conditions for a run. The instructor/planner must enter the opponent(s)' type of aircraft involved, each aircraft's configuration (size and armament), altitude and speed, relative positions of the adversary(s) in geographic position, and other parameters to be recorded and the conditions which trigger the crash simulation. Up to 16 ICs can be programmed for 1 vs 1 (independent mode) and up to 16 for 2 vs 1 (cooperative mode). It does not provide for the control of any of

the events, or the target, after the run or event has begun, i.e., "operate" has been selected. It does not provide for the planning or programming of specific training events or of a syllabus. Figure 31 outlines the Plan Mode tasks. A detailed task flow is contained in Appendix C.

FD-21. Limited Training Event Programming Capability. The Plan Mode does not permit the programming of the basic characteristics of the event or of all of the initial conditions which must be set as part of the IC. These include programmed target "skill" level, programmed target weapons firing authority, ACMR tone selection, initial display selections including ACM scale, and g and buffet simulation parameters. While these can be set by the MO or instructor at the console, they could equally as well form part of the programmed IC and relieve the Instructor/MO of the task of completing the IC specification. Modification of event parameters such as target skill levels, overrides, refueling, rearming, and relative positions could still be modified in real time at the console.

ICs are not related to the syllabus. Thus the instructor cannot directly address the IC relevant to the training event scheduled without referring to notes or checking the syllabus folder. While this is not a difficult problem, especially in a part mission trainer, the planning capability of a trainer should support the syllabus rather than simply providing IC options.

Programming support of training events such as air-to-air engagements can include the development and specification of "intelligent" targets, i.e. targets that respond to the level of the skill of the trainees and training objectives.

TRAIN IP FUNCTION. The 2E6 is the only trainer surveyed that incorporates a training module for operation of the device. The software module is activated as one of the primary modes of the trainer and utilizes the displays to demonstrate, describe and guide the "student" through the operation of the console. Figure 32 is a printed sample of a CRT page from the IP Train Mode.

FD-22. Training Mode Package Deficiency. The training package was apparently designed for training an IP or IRIO to operate the device; the position now filled by the MO. The module is not utilized by the MO since he is already well qualified in the operation of the device. The module was not designed to train the IP in the functions now performed by him at the CRT 1/2 position consisting primarily of monitoring aircrew performance and flying the manual target/aircraft. Thus the training capabilities are not well designed and consequently, not utilized.

SELF/PEER TRAINING. The 2E6 does not provide a capability for aircrew training without an instructor or MO at the console.

FD-23. Self/Peer Training Deficiencies. The training

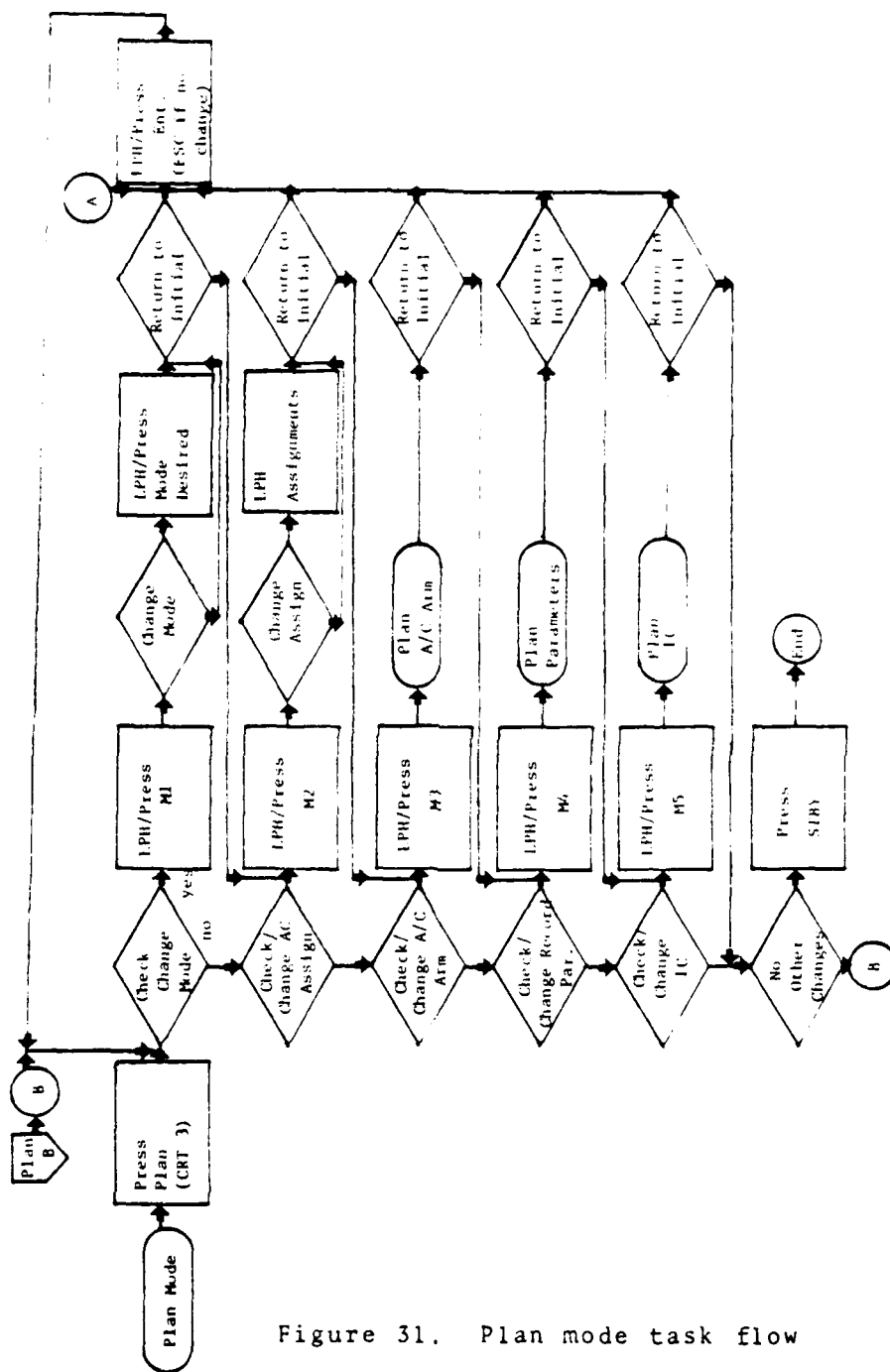


Figure 31. Plan mode task flow

# INSTRUCTOR TRAINING PILOT TRAINING MODE

THE RESET OF IDLE EXERCISE WHICH NORMALLY IS ON THIS REVIEW THE PROBLEM OR SETTING OF A  
NUMBER SUMMARY 'PRS' AND 'IC' KEYS ARE USED TO THE THIS CRT IS ON CRT 1.  
IC SUMMARY 'PRS' AND 'IC' KEYS ARE USED TO THE THIS CRT IS ON CRT 1.  
THE 'PRS' AND 'IC' KEYS ARE USED TO THE THIS CRT IS ON CRT 1.  
TWO PAGES IS DISPLAYED. THE PROBLEM THE IC SUMMARY SHOWS THE  
CURRENT TRAINING CONFIGURATION. FOR THE IC NUMBER SELECTED ON THE  
THE IC CONDITIONS FOR THE IC NUMBER SELECTED ON THE  
RESET IDLE DISPLAY.  
THE KEYBOARD IS USED TO ENTER THE RUN AND IC NUMBERS.  
IF AN ERROR IS MADE DURING ENTRY, THE 'ESC' KEY WILL  
RESTORE THE PREVIOUS RUN AND IC NUMBER. THE 'ENT' KEY  
WILL SAVE NEW ENTRIES. A BLANK ENTRY FOR RUN OR IC  
NUMBER WILL NOT CHANGE THE ENTRY.  
THE 'RET' KEY WILL RETURN TO THE MODE SELECT DISPLAY TO  
ALLOW SELECTION OF A NEW MODE (INDEPENDENT OR INTERRELATED).

NOTE: THE FOLLOWING RUN IS A SPECIAL TRAINING RUN AND  
WILL NOT REFLECT DATA PRESENTED ON THE PROBLEM OR IC  
SUMMARIES. ONLY CRT 3 IS USED FOR REAL TIME DISPLAY.  
NO DEBRIEF TAPE IS REQUIRED IN IP TRAINING MODE.  
PRESS:  KEY TO EXIT TO INSTRUCTOR TRAINING  
MODE INITIALIZATION

Figure 32. Sample IP train mode page

capabilities of the system. The system is designed to enable the  
aircrew to practice A-M operations in a realistic manner, including  
MC at the console. While operating in MC, the system enables the  
PBRIO to monitor and control the aircraft's performance and to  
conceivably practice fast, accurate, and efficient A-M operations  
in a semiautomated manner. The system is designed to allow  
supporting the operation at the console.

W. 3.11. ANEUS. A major problem also found in the surveys of the  
trainers, involves the instructor and operator  
documentation provided. The existing documentation is a single  
document which does not meet any of the specific needs such as  
a training manual, an operating handbook or for a technical  
description of the implementation.

## SECTION IV

## DISCUSSION

## GENERAL

Training device 2E6 Aircombat Maneuvering Trainer was procured as a part-mission trainer to be operated by IPs and supported by technician operators. However, as reviewed in the Introduction, the decision was subsequently made to man the trainer with professional operators to reduce IP training requirements and enhance trainer utilization. As with other trainers which are being operated by professional operators such as the 2F112, potentially major operating problems can arise. These result from the fact that the manning change was made after the IOs had been specified and designed, and without analyzing the resulting implicit allocation of functions and tasks or their related display/control requirements. In short, the IOSs were not designed for the MO manning concept.

## CURRENT USAGE

A limited review of the background documentation and procurement history was conducted when the varied and evolving utilization of the trainer suggested that training objectives and performance criteria had not been stated nor syllabi developed early in the trainer development process. It does not appear that analyses such as outlined in the Instruction Systems Development (ISD) process or the Training Situation Analysis (TSA) instructions and guides were performed. The testing outlined in the specification addresses primarily hardware, software and simulation characteristics testing. Although one of the purposes of the Navy Preliminary Evaluation (NPE) was "...to determine at the earliest possible opportunity, the training potential..." such an evaluation would be difficult in the absence of training objectives and at least a draft syllabus.

**MANNING.** The MO IOS manning concept involves allocating the responsibility and control over the implementation of the simulation to the MO, thus freeing the IP/IRIO to monitor aircrew performance and manage the objectives of the training event. This results in different control and display requirements. The MO requires controls and displays to manage and operate the simulator while the instructors require controls and displays to manage training. The original design was based on the premise that the IP station (now the MO station), would be utilized for both functions with technical support from a technician-operator. The result, as will be discussed further, is that the new IP station (CRT 1 and 2) has insufficient control (and display) for the IP to perform his training function.

**MODE UTILIZATION.** The utilization of the four different operating

modes of the trainer (except for the training mode) differs from that found in other trainers both because of the part mission function of the trainer and because of significant differences in the mechanization.

The Plan mode in the 2E6 is limited to defining initial conditions and therefore is used during training as well as during non-training periods to create and modify ICs. The mode does not provide for the development of dynamic scenarios or "intelligent" targets. Sequential runs related to the syllabus or to attack problems cannot be "stacked."

The Demonstration mode was not used extensively at the time of the survey. However the plans are to utilize it routinely with many of the syllabus events when the demonstrations have been created. When implemented, this will represent a major difference from the other trainers surveyed in which the demonstration capability was rarely if ever used.

The IP/TNG mode while providing a needed training capability, is not utilized for two reasons. First, the training module was not designed to the MO manning concept and as a result, does not meet the training requirements of either the MO or the instructors. Secondly, the design of the module constrains its use. The module is operable only as a primary trainer mode and thus expends "aircrew training time" when used. Finally, the module was not designed around training objectives nor does it utilize state-of-the-art computer supported training methodology.

#### DESIGN PROBLEMS

In addition to the problems created by the change in the manning concept, many problems were found which reflect the overall lack of human engineering analysis during the design and of application of basic human engineering design criteria to the design of the system. This exists and occurred in spite of the fact that relevant standards and specifications (e.g., MIL-STD-1472 Human Engineering Criteria for Military Systems, Equipment and Facilities and MIL-H-46855 Human Engineering Requirements for Military Systems, Equipment, and Facilities) and related testing requirements were incorporated in the device specification.

The problems will be discussed in terms of the following topics:

- a. console layout problems,
- b. control and display problems,
- c. training function problems.

CONSOLE LAYOUT PROBLEMS. The console layout problems analyzed include both console location problems and configuration



problems. The latter directly reflect the manning approach implemented.

Console Location. As with other trainers surveyed, little attention appears to have been paid to the design of the IOS spaces or to the location of the IOS in the space (see LP-1). The 2E6 consoles as installed, are open to almost all traffic in the training area including observers, kibitzers, visitors, and maintenance men working in the area. In addition, aircrews are briefed in the console area. The impact of the latter can be expected to create further congestion and confusion when both trainers are operated in the independent mode since the common space between the consoles is used for the briefing. Additional problems can be created by the spillage of light from the high bay area which falls almost directly on the CRTs as now located. Finally, the instructor/operator staff cannot monitor the dome areas from their seated positions. Although not critical, the task can only be reliably performed by the console staff.

Console Orientation. Reorienting the consoles so that they face the dome/bay area and are partially isolated from each other could solve many of the problems outlined above. Since coordination between the two consoles is never required (only one console is used in the integrated mode), some separation of the consoles is also possible, thus further reducing interacting noise levels at each console. The aircrew briefing problem could be solved by utilizing other space available in the area which could be adapted (and dedicated) to this function.

The printer location one floor below the console area discourages use of hard copy (LP-2). This will become even more significant when a performance measurement system becomes available. Relocation of a printer to the console area would solve the problem.

Console Configuration. The console configuration problems reflect primarily the impact of the professional operator or mission operator manning approach. As pointed out in the Results Section, the utilization of the MO at the console simplifies the IP training problem and provides the trainer the operating support required to conduct the training evolutions. However it creates a new set of problems in that the console was not designed to this manning approach and in effect, satisfies neither the needs of the IP or of the MO (e.g., LP-3, -4, -5).

The most serious problems are created for the IP since the only controls directly available to him, except for those related to manually flying simulated aircraft, are display controls. He has no direct access to the data pages which are displayed on CRT 3 or the controls over basic scenario elements such as weapons inhibit, PT maneuvering level and comment erase. Of even more importance, the IP has no control of the basic training features such as freeze, operate, reset, replay, or comment entry. Thus the IP can only accomplish many of his primary functions through

MO with consequent time delays and potential for error as well as possible disruption of MO tasks. The end result is probably limited use of the training features by the IP (e.g., FD-14, -16).

**SUMMARY.** The 2E6 exhibits serious problems in terms of location and orientation of the consoles as well as in basic console display and control configuration. These problems result from the lack of adequate attention to the design of the console spaces and to the tasks and functions of the personnel manning the console and directly reflect the lack of task analysis effort during the design and development process. The display and control configuration of the consoles severely constrain the inputs of the IP, especially in terms of scenario control and utilization of basic trainer training features.

#### CONTROL AND DISPLAY PROBLEMS

In addition to the typical human engineering problems found in the other trainers surveyed, some new problems were found in the 2E6. Although not as serious as some those found in the WSTs for example, primarily because of the relative simplicity of the training mission of the 2E6, the end result must be reflected in reduced effectiveness of the trainer. In general, the problems could have been prevented through adequate human factors engineering of the controls and displays and their interactions.

The problems of control and indicator discrimination (CDP-1), color coding (CDP-2), control-indicator labeling (CDP-3 and CDP-4), legend/console illumination (CDP-5), non-functional controls/indicators (FP-5), unnecessary controls (CDP-4, -6, -12), inconsistent control operation (CDP-10, -11) and similar problems were discussed in detail in the previous reports. The problems and the solutions are similar in the case of the 2E6 and will not be reviewed again.

The unique problems found in the 2E6 reflect the complexity of the ACM simulation, especially where more than two aircraft are involved. These problems include:

- a. confusing flight instrument readout selection (CDP-8),
- b. confusing display of relative altitudes and bearings of targets and other aircraft (CDP-9),
- c. confusing data on the source of the "Out-of-Cockpit View" (CDP-13).

The problems have become more constraining for the IP since there is no longer a requirement to be qualified in the operation of the trainer.

The data printout format, i.e., in scientific notation is also unique and has proven unsatisfactory since it is not in user

format. In addition, as will be discussed with functional problems, the content of the data has proven of little value and would be extremely difficult to interpret at best.

SUMMARY. Although some new problems were found in the 2E6, the majority of the control and display problems are similar to those found in the other trainers surveyed and reflect the lack of adequate task analysis and application of basic human factors engineering design criteria.

#### FUNCTIONAL PROBLEMS.

Although the 2E6 as designed, incorporates support for some training functions not supported in the other trainers surveyed, many of the same functional deficiencies were also found. Thus of the 10 functions used in the survey, the 2E6 does not support the:

- a. prepare function,
- b. brief function,
- c. evaluate function,
- d. manage data function,
- e. student/peer training function.

In addition, it marginally supports the develop syllabus/training event function and the train instructor/operator function, the former because only ICs can be developed in the Plan mode and the latter because the IP/TNG module was not designed to the current manning approach. Only the debrief function is supported parallel to training, i.e., both training and debriefing can be conducted at the same time. The instructor training module should be similarly implemented.

The Initialize function has unique problems in that the Plan mode may have to be accessed during the training session to create the initial conditions desired or to establish the details of the initial condition selected. The lack of descriptive data to identify the conditions selected exists not only for the IC but also for the demonstrations.

Because of the manning approach used and the configuration of the console, the Train function as implemented poses severe constraints on the instructor. For example, as pointed out in the Results Section, the instructor station at the console does not provide the basic training controls such as freeze, reset, operate and replay (the controls are located at the MO station).

Although the device has the capability for recording and printing extensive data on selected parameters, the output is not in a usable form nor reduced or summarized so as to be useful

to the instructor. The debrief data printout presents the same problems. Thus the capability is not utilized except for special tests or experiments. The remote location of the printer further discourages the use of any hard copy data. However this could be readily rectified by locating a printer in the console area.

The debrief facility while a major step forward relative to the other trainers surveyed, poses several problems which may constrain its eventual use. These are primarily operability problems including difficulties in debrief tape initialization, and access to selected points in the recording. The location and arrangement of the debrief station is not optimum and will detract from its acceptability and use. The problems should be relatively easy to remedy.

In addition to the major training function support problems, a variety of other function related problems were found. Again, they result from the lack of front-end analysis, especially training and user task analyses. These problems are similar to those found in other trainers and include unused initialization procedures ranging from crew data inputs (FP-11) to dome readiness procedures (FP-5, -7) to display controls (FP-4). Other limitations common to most trainers include the necessity to manually simulate all communications relevant to the training event as well as control the position and major characteristics of the target since the Plan mode is limited basically to initial conditions only. The target maneuvering options are limited and appear to be "learned" by the student in a few trials. Some randomization of the maneuvering within each model option could be implemented. For advanced training, maneuvering models based on threat characteristics should be developed. It appears that realistic control of a target aircraft from the instructor console is probably not a feasible option.

In summary, while the J26 provides some training features not found in other trainers surveyed and which will prove useful, the overall instructor console design problems significantly impact operability and training function capability and can be expected to limit its effectiveness.

## SECTION V

### CONCLUSIONS

#### GENERAL

While Device 2E6 incorporates some training features not implemented in the other trainers surveyed, the general results parallel those findings in terms of basic design deficiencies. Operability problems which stem from the decision to utilize mission operators to support the instructors as well from the lack of training and human factors analyses and design were again found. However the 2E6 IOS also presents new problems, some of which result from the part mission training objectives of the device. Some of the problems also reflect different design approaches to trainer mechanization. Most contain similar problems in terms of function and operation. The former are to be expected in the absence of definitive requirements and training objectives. The lack of a detailed syllabus during design and especially during testing, for example, literally precludes the design of an effective and efficient IOS. While the resulting IOSs are operable and accepted, the effectiveness achieved reflects considerable "can do" and "make it work" efforts on the part of the MOs and instructor personnel.

The trainer was not observed operating in the integrated mode nor was the debriefing capability available during the period of the survey. However, sufficient data were available from the technical manuals, the trainer technicians and the Squadron training staffs to include these features and capabilities in the analysis.

#### SPECIFIC CONCLUSIONS

The following specific conclusions are grouped in terms of the major design headings under which they were discussed.

**CONSOLE STATION LAYOUT.** In general, the layout and arrangement of the IOSs present major problems to the efficient operation of the trainer(s).

a. The arrangement of the consoles places the console staff in the main trainer traffic flow, invites observation and eavesdropping, precludes observation of the dome areas and can result in display readability problems from light spillage from the high bay area.

b. The configuration of the consoles severely constrains training functions of the IP/IRIO since control of the basic training features of the device such as freeze, reset, operate and replay, as well as other controls and important displays, are not available at the station now occupied by the MO.

**DISPLAY PROBLEMS.** The console is CRT display oriented as the other trainers surveyed have been. However, the page design approach utilized in the 2E6 is almost the exact opposite of that used in Device 2F112 and Device 2F119. The latter trainer's CRT pages were designed with a high density of information and with multiple data entry options and controls on each page. The 2E6, on the other hand, was designed with limited data and control options on each page.

a. The CRT data pages do not provide sufficient information or control options for efficient control of the trainer or of the training event. The end result is excessive paging and the lack of summary data on the training scenario being initialized or underway.

b. Insufficient flight and systems information is available to permit an instructor to fly the "manual" target/aircraft without extensive training and experience on the task. Even when trained sufficiently to perform the task, the demands of the flying task preclude effective monitoring of the aircrew's performance or management of the training situation.

c. Identification of the display option being presented, especially for the OCV and the cockpit instruments, is difficult. The relative position indicators compound the problem. The display options permit major discontinuities to exist, e.g. the cockpit instruments from one simulated aircraft and the OCV from a different aircraft.

d. Performance data formats and printouts are not in a usable format nor usable for performance evaluation.

e. Developing and storing a demonstration is unnecessarily complex and will constrain its utilization in training.

f. Recording of events for debriefing is complex and constrains its use as well as training event initialization.

g. The design of the displays reveals a wide variety of human engineering discrepancies ranging from the non-standard and inconsistent use of color coding, inadequate and confusing panel control labeling and inadequate lighting of legends to non-functional and error producing panel layout and arrangement.

**CONTROLS.** The control mechanization incorporated in the 2E6 is, in general, similar to that found in the other trainers surveyed. Similar problems have resulted. The controls include light pen, alphanumeric keyboard, and function keys in addition to knobs and control/joy sticks.

a. A wide variety of non-functional controls exist on the console as a result of changes to the training procedures (e.g., use of oxygen simulation), unnecessary controls (e.g.,

joystick trim controls and alpha-numeric keyboard) and non-functional controls (e.g., blank switches and switches not used because of modifications such as the hand rail control switch).

b. The instructor (IP or IRI0) station does not contain the controls essential to implementing the training event and monitoring aircrew performance.

c. The use of the light pen, function keys and alpha-numeric keyboard for function implementation is inconsistent and depends on instructor training and experience to achieve operability and error free operation.

TRAINING FUNCTION SUPPORT. The 2E6 provides no support to many training functions as was found in the other trainers surveyed. The implementation of the Debrief Facility and IP/TNG mode in the 2E6 are significant exceptions in that they potentially provide support for the debrief and instructor training functions.

a. The 2E6 provides no or very limited support to basic training functions including:

- (1) preparation function,
- (2) brief aircrew and training staff function,
- (3) evaluate aircrew performance function,
- (4) manage data function,
- (5) develop syllabus/training event function,
- (6) student/peer practice training function.

In addition, the trainer as mechanized provides limited support to the initialization and instructor training functions, the former because of the design and the latter because of both the design and the changes made to the manning concept.

b. Access to training event/run IC data is limited and constrains the instructor's implementation of the syllabus. Training ICs are identified by number only, with no reference to syllabus or data source. As a result, the instructor has no information as to the detailed characteristics of the event which has or will be initialized, much less its relationship to the training syllabus being implemented. The same problem exists for demonstration and debrief event access.

c. Training event initialization is complex and typically requires accessing the Plan mode to identify the conditions to be initialized or to modify the IC addressed. The Plan mode and the initializing function (and train function) are intertwined.

d. The 2E6 provides no effective support to the evaluation function. Performance data summarization is not implemented. The existing debrief data output is essentially unusable. It is neither in operationally relevant terms (e.g., digital print out of selected parameters at a fixed sample rate) nor in terms directly meaningful to the instructors (e.g., scientific notation).

e. The 2E6 provides no support to event relevant simulations such as background communications, controller functions and inter-weapon system communications. The instructor is required to manually provide these simulations without any support from the trainer to the detriment of aircrew performance monitoring.

f. As with the other trainers surveyed, the instructor relevant documentation is neither in user terminology nor is it training event implementation oriented. No operational guides or checklists are available.

#### SUMMARY

While the 2E6 provides some training features not provided by other trainers surveyed, it also contains design deficiencies not evident in the other devices. The former includes the instructor training mode and the debriefing capability; the latter includes a variety of mechanizations such as the limited data/control CRT page, limited programming mode capability and limited instructor station training control and display capability. The instructor training mode is essentially ineffective since it meets neither the instructor nor the MO training requirements. The debriefing capability is constrained by debrief mode implementation difficulties and facility constraints. The CRT page design results in minimum data presentation while extending control input requirements. The programming mode is in effect an extension of the initialization mode and does not provide an effective training event programming capability. The most severe constraint on the trainer's effectiveness probably results from the limited instructor training control capability, especially in terms of basic training feature control such as freeze, operate, reset, and replay as well as on-line simulation modifications such as programmed target performance capabilities and override features.



## SECTION IV

### RECOMMENDATIONS

#### GENERAL

A wide variety of enhancements to the 2E6 instructor operator console (and debrief facility) are feasible and if implemented, could enhance the training effectiveness of the device. However, most of the feasible changes, except for human engineering "cosmetic effects," should not be undertaken without conducting at least a limited analysis of the training and console requirements in terms of current ACM training objectives and device manning policy. As discussed, the implementation of the MO manning concept significantly changed the console display, control and arrangement requirements after the console had been designed and installed. To undertake changes in the absence of requirements data could prove as detrimental as modifying the operating approach after the console is designed. Thus if changes are to be implemented, a human factors, training systems approach should be undertaken rather than a "component change" approach to optimize the probability of enhancing the IOS effectively. Of particular importance is the consideration of the instructor-MO interactions in both aircrew routine training and qualification validation. The interaction problem can only be defined through detailed analysis, not through trial and error changes.

Recommendation 1. Conduct at least a limited console and training requirements analysis. As discussed, a detailed trainer-training requirements and objectives analysis is essential to identify the functional characteristics and detailed design characteristics for any IOS change. The analysis should consider and reflect the major users of the device including the readiness training squadrons, the fleet squadrons, the adversary squadron and the related syllabi and training objectives. The analysis must identify the constraints involved for the various users.

The following specific recommendations are made with the caveat that any change made without adequate analysis of the training requirements and objectives involved may prove ineffective, inefficient, or at worst, detrimental to training.

Recommendation 2. Modifications to the IOS layout should be undertaken to meet the unique and specific control and display requirements of the MO and the IP or IRIO. The changes required appear feasible since the stations are CRT oriented and the addition of the required controls could be implemented in either hardware or software. However, these modifications require the explicit identification of the control/display requirements of the MO and of the instructors, and should not be deduced from

experiential data. An important change which should be implemented is to provide the instructor with the basic training feature controls such as freeze, operate, replay and reset. Additional training controls will be required and identified in the recommended analysis (Recommendation 1).

Recommendation 3. Reorientation of the two consoles to reduce the existing open access to the console stations should be undertaken. For example, a 180 degree shift in console orientation would not only provide a measure of privacy to the instructor/operator console, but would limit high bay lighting spillage on the console CRTs and permit instructor/MO monitoring of the access to the domes. Further separation of the two consoles would limit noise and related interference between the two consoles in the independent mode. If the debriefing facility is not utilized for briefing, a separate area should be designated and suitable equipped for that purpose.

Recommendation 4. A console station for manual flying of a simulated target or aircraft (if required) should be implemented at the console but separate from the instructing station. The two functions do not appear to be compatible. If implemented, the station should provide the flight and system information necessary to perform the flight control task.

Recommendation 5. The instructor training module should be modified to support instructor station operating training requirements. The implementation should be modified to permit parallel use with the training mode, i.e., an instructor can be utilizing the instructor training mode while aircrew training is being conducted. A separate console operating refresher training module for the MO is also recommended.

Recommendation 6. Objective performance measurement is an essential input to instructor evaluation of aircrew performance. However, the input if it is to be utilized, must be in a form both meaningful to and usable by the instructor. Performance measurement systems and models can be developed to meet this requirement.

Recommendation 7. An effective programming or "plan" mode should be developed to meet the various syllabi objectives. The mode should permit syllabus and event development while still permitting simple modification by the instructor in the training mode. It should be distinct from the initialization feature. The capability should provide for programming of all basic event parameters including target "skill" levels. The implementation of the F-14 Instructor Support System (ISS) could serve as a model for implementing this capability.

Recommendation 8. At least limited background communications simulation should be provided. The instructor should be relieved of as many manual simulation requirements as possible to permit his concentration on aircrew performance monitoring and evaluation

and training event management. Both tape and digital speech systems are available and could be used to meet this need.

Recommendation 9. The CRT data pages should be redesigned to provide the information required at each point of trainer operations. The existing limited data pages, especially for initializing the trainer, result in excessive paging to maintain the required overview of the IC.

Recommendation 10. ICs and demonstrations should be indexed and ICs should bear some meaningful identification. Debrief events should also bear some identification to facilitate access.

Recommendation 11. Initialization procedures for training events and demonstration and debriefing recording should be simplified. An IC (unless modified) should initialize all parameters for the event. Debrief recording should be continuous and then, for example, unless "saved", could be written over. The creation and saving of a demonstration is unnecessarily complex and should be simplified.

Recommendation 12. As recommended in the reports of the previous surveys, improved documentation relevant to the instructor and the MO is required. The existing documentation is not user or function oriented.

Recommendation 13. As recommended in the reports of the previous surveys, revised trainer procurement procedures and guiding documents should be developed to preclude the recurrence of the problems surfaced in this survey.

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APPENDIX A  
SAMPLE 2E6 DISPLAY PAGES

RESET IDLE  
COPY FLAG COMMENTS

RUN NO. 2

COPY FLAGS					
TIME	COMMENT	TIME	COMMENT	TIME	COMMENT
13.9	IP FIRE 7F				
70.0	IP FIRE 7F				
81.9	IP FIRE 7F				
99.2					
110.4	IP FIRE 9L				
132.9	IP FIRE 9L				
138.5	RANGE LIM				
160.5	IP FIRE 7F				

USE THE KEYBOARD TO ENTER  
COMMENTS AND THE LIGHT PEN  
TO SELECT THE TIME AND  
STORE THE COMMENTS

PRESS: **ENT** TO EXIT TO RESET IDLE

☐ STORE COMMENTS

COMMENTS: RANGE LIM

Figure A-1. Copy flag comments

RESET IDLE  
DATA SAVE

THE DATA SAVE MODE SWITCH IS IN THE MANUAL  
MODE. TO SAVE THE RECORDED DATA FOR THIS RUN  
PUSH THE RUN SAVE BUTTON ON THE  
MASTER CONTROL PANEL.

256 SECONDS OF DATA WAS SAVED ON THIS RUN  
3544 SECONDS REMAINING ON THE DEBRIEF TAPE IF  
THE DATA FROM THIS RUN IS SAVED

PRESS:  TO EXIT TO RESET IDLE  
 TO REQUEST A NEW DEBRIEF  
AND TO EXIT TO RESET IDLE


Figure A-2. Data save - MAN


TRAINING MODE SELECTION

☒ INDEPENDENT

☐ INTEGRATED

USE THE LIGHT PEN TO MAKE SELECTIONS

PRESS:  KEY TO EXIT TO PLAN MODE INITIALIZATION

 KEY TO SAVE DATA AND RETURN


 KEY TO SAVE DATA AND EXIT TO SELECT TRAINER ASSIGNMENT

Figure A-5. Training mode selection



TRAINER ASSIGNMENT  
INDEPENDENT MODE

SELECT OPPONENTS

<input type="checkbox"/>	TR1 VS IP	<input type="checkbox"/>	TR1 VS IP VS PT
<input type="checkbox"/>	TR1 VS PT	<input checked="" type="checkbox"/>	TR1 VS PT1 VS PT2
<input type="checkbox"/>	IP VS PT		

SELECT OPPONENT(S) FOR PT(S)

<input checked="" type="checkbox"/>	TR1	<input checked="" type="checkbox"/>	TR1
PT1		PT2	
<input type="checkbox"/>	PT2	<input type="checkbox"/>	PT1

USE THE LIGHT PEN TO MAKE SELECTIONS

PRESS :  KEY TO EXIT TO PLAN MODE INITIALIZATION

KEY TO SAVE DATA AND RETURN

KEY TO SAVE DATA AND EXIT TO SELECT AIRCRAFT/WEAPONS CONFIGURATION

Figure A-4. Trainer assignment

AIRCRAFT TYPE SELECTION  
INDEPENDENT MODE

STATION	FUEL	F-14A	F-4J	F-4S	F-15A	THRT 1	THRT 2
TR 1	100 ^	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
PT	100	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

USE LIGHT PEN TO SELECT AIRCRAFT TYPES REQUIRED.  
ENTER PERCENT INTERNAL FUEL AT POSITION MARKED BY ^

PRESS:  KEY TO EXIT TO PLAN MODE INITIALIZATION  
 KEY TO SAVE DATA AND EXIT TO SELECT WEAPON LOADING

Figure A-5. Aircraft type selection

AD-A138 972

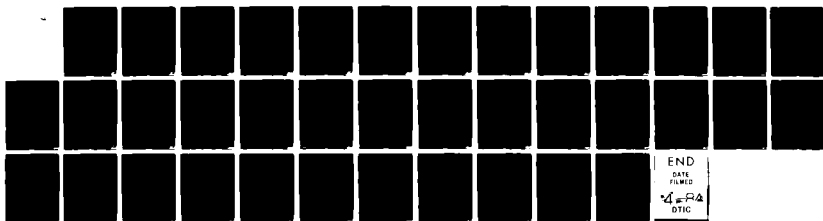
2/2  
DEVICE 2E6 (ACMS) AIR COMBAT MANEUVERING SIMULATOR  
INSTRUCTOR CONSOLE REVIEW(U) ICON INC SAN DIEGO CA  
J P CHARLES DEC 83 NAVTRAEQUIPC-82-M-0767-1

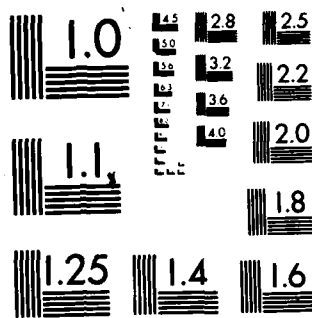
UNCLASSIFIED

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F/G 5/9

NL





MICROCOPY RESOLUTION TEST CHART  
NATIONAL BUREAU OF STANDARDS-1963-A

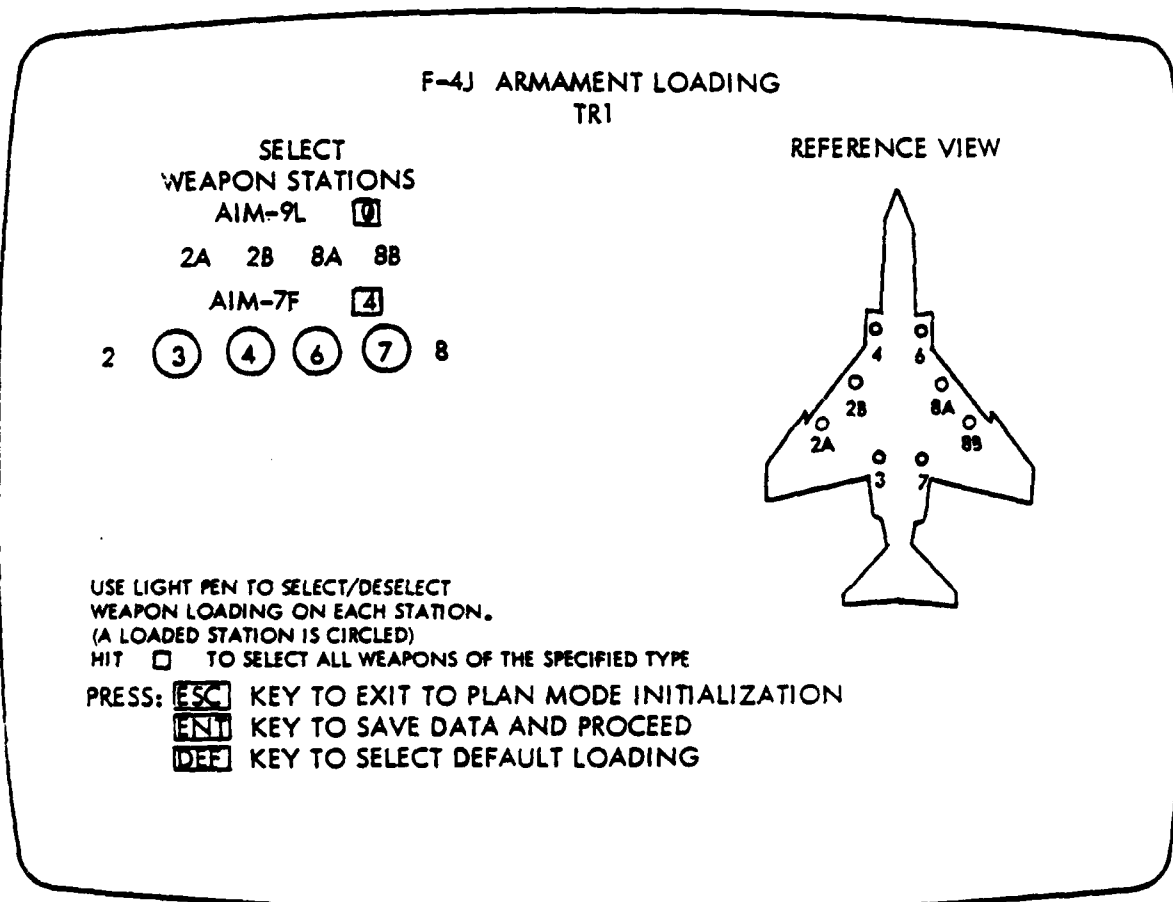






Figure A-6. F-4J armament loading

FLIGHT DATA INITIAL CONDITIONS

PRESS:  KEY TO EXIT TO PLAN MODE INITIALIZATION  
 KEY TO SAVE DATA AND RETURN  
 KEY TO CHANGE THE PLAN MODE IC  
 KEY TO REPLACE ANY IC WITH THE CURRENT  
PLAN MODE IC

SELECT IC SUMMARY OF THE BOXED  
IC NUMBER WITH THE LIGHT PEN

1	2	3	4	5	6	7	8
9	10	11	12	13	14	15	PM

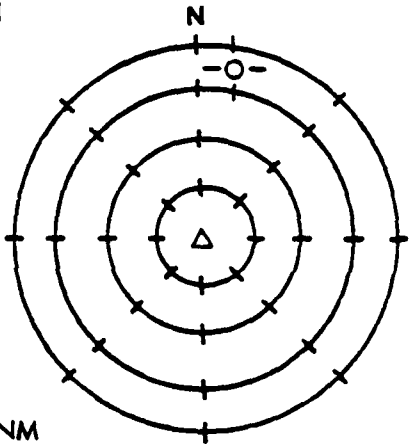
Figure A-7. Flight data initial conditions

PLAN MODE IC      FLIGHT DATA INITIALIZATION

1 VS 1

SELECT RANGE SCALE  
NM/FT PER RING

- ☐ 25 NM
- ☐ 10 NM
- ☐ 5 NM
- ☒ 1 NM
- ☐ 2500 FT
- ☐ 1000 FT
- ☐ 500 FT



RANGE 3.30 NM

1 NM PER RING

△ TRI  
○ FT

USE JOYSTICK TO POSITION AIRCRAFT

PRESS: IC KEY TO SAVE POSITION

ESC KEY TO EXIT TO PLAN

MODE INITIALIZATION

ENT KEY WHEN SELECTIONS

ARE COMPLETE

Figure A-8. Flight data initialization

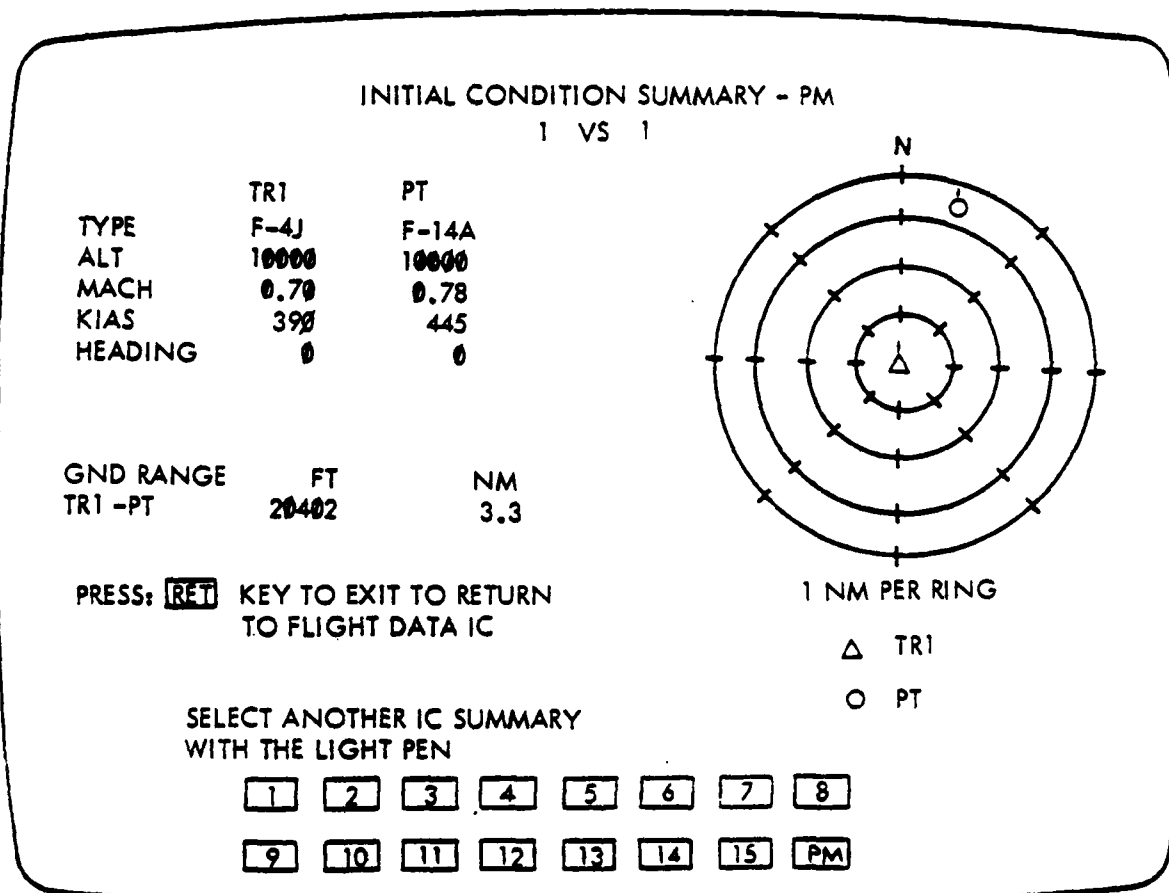


Figure A-9. Initial conditions summary



FLIGHT DATA INITIAL CONDITIONS

SELECT IC NUMBER WHICH WILL BE  
REPLACED BY THE PLAN MODE IC

1	2	3	4	5	6	7	8
9	10	11	12	13	14	15	PM

Figure A-10. Flight data initial conditions

PLAN MODE  
INITIALIZATION

USE THE KEYBOARD AND/OR LIGHT PEN TO SELECT PLAN MODE OPTIONS AS SPECIFIED. COMPLY WITH 'PRESS' COMMANDS USING EITHER THE LIGHT PEN OR KEYBOARD. A BOXED ITEM INDICATES A LIGHT PEN ENTRY. USE DEL AND BKSP KEYS TO CORRECT TYPING ERRORS. THE ERS KEY CAN BE USED TO ERASE ALL ENTRIES FROM A SELECTED DISPLAY.

PRESS: 

M1
----

 KEY TO CHANGE TRAINING MODE  

M2
----

 KEY TO SELECT TRAINER ASSIGNMENT  

M3
----

 KEY TO SELECT AIRCRAFT/WEAPONS CONFIGURATION  

M4
----

 KEY TO SELECT PARAMETER RECORDING LIST  

M5
----

 KEY TO SELECT FLIGHT DATA INITIAL CONDITIONS

Figure A-11. Plan mode initialization

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APPENDIX B  
GENERIC TRAINING FUNCTIONS

GENERIC TRAINING FUNCTIONS

I PREPARE FUNCTION

- 1.1 Identify Session
  - student
  - time
  - simulator
  - syllabus event
  - simulator status
- 1.2 Assemble Materials
  - student file
  - syllabus hop description
  - scripts
  - scenarios
  - checklists/guides
  - initialization data
  - data recording sheets
  - grade sheets
  - simulator utilization sheets
  - flight plans, etc.
- 1.3 Review Data
  - student history (e.g., performance problems, weaknesses, missing training events)
  - syllabus event (e.g., objectives, performance criteria, priorities, implementation procedures, contingency plans)
  - simulator status and configuration
- 1.4 Develop Training Session
  - individualize syllabus to student's needs
  - modify initial conditions as required
  - schedule and program malfunctions/emergencies
  - structure controller functions
  - develop tactical scenario
  - format demonstrations
  - structure performance measurement
  - develop contingency plans (e.g., performance failures, crashes, missed procedures, simulator reset strategy, simulator emergencies such as fire, hydraulic failure, loss of communications)
  - outline briefing (e.g., objectives, criteria, procedures, simulator problems)

II BRIEF FUNCTION

- 2.1 Brief Student(s)
  - planned evolution
  - learning objectives
  - performance criteria
  - simulator emergency procedures

- simulator discrepancies, and characteristics
- planned use of training controls such as freeze, reset, replay, demonstration
- communication procedures
- flight plan data

#### 2.2 Brief Simulator Training Staff

- planned evolution
- support responsibilities
- emergency procedures

### III INITIALIZE FUNCTION

#### 3.1 Configure Simulator

- configure simulation system
- configure crew station(s)
- configure IOS

#### 3.2 Initialize Simulator

- enter/verify initial conditions
  - o airfield/carrier location, runway/heading, etc.
  - o radio/navigation aids, locations, characteristics
  - o target locations, characteristics, behavior
  - o environment including weather, altitudes, temperatures, winds, magnetic variation, etc.
  - o aircraft configuration
  - o aircraft position and state
  - o preprogrammed malfunctions, emergencies
  - o data monitoring, recording

#### 3.3 Establish Readiness

- student(s) strapped in cockpit
- area secure and safe
- scripts, scenarios, data sheets, etc., available
- communication check with students

### IV TRAIN FUNCTION

#### 4.1 Control Simulator

- activate simulation
- provide manual simulations e.g., communications, controller functions, ground crew functions, "missing" aircrew functions, other platform functions such as surface threats
- activate/deactivate emergencies, malfunctions
- select and activate demonstrations
- set and select replay
- freeze simulator
- initialize and reset
- monitor safety of operation
- deactivate trainer at end of session

#### 4.2 Monitor Performance

- procedures
- technique
- skill level

- simulator performance

4.3 Instruct

- provide feedback
- critique
- correct procedures, errors
- advise

4.4 Record

- data for feedback
- data for simulator control, i.e., reset, replay

points

- data for debrief
- data for records

V EVALUATE FUNCTION

5.1 Monitor relevant parameters for segment, phase, task

5.2 Establish if performance is within training  
performance envelope

5.3 Diagnose problem if performance is inadequate

5.4 Select instruction technique for remediation

5.5 Develop plan and data to implement remediation

5.6 Brief simulator crew and student(s) as required

VI DEBRIEF FUNCTION

6.1 Debrief Student

- organize data collected
- assemble debriefing materials, e.g., hard copy
- review performance problems (replay as required)
- review correct procedures
- outline corrective actions to be taken

6.2 Debrief Simulator Staff

- review event implementation problems
- review overall performance
- discuss simulator discrepancies

VII MANAGE DATA FUNCTION

7.1 Student Data

- prepare grade sheets, training sheets
- prepare training data sheets

7.2 Simulator System Data

- utilization data sheets
- discrepancy data sheets

7.3 Training Data

- problems encountered in event
- changes tried, recommended
- instruction problems, recommendations

VIII DEVELOP SYLLABUS FUNCTION

- 8.1 Identify Changes Required
- 8.2 Format Changes
- 8.3 Implement Changes
- 8.4 Validate Changes

IX TRAIN IP FUNCTION

- 9.1 Simulator Operation
  - console familiarization
  - console operation
  - operating procedures
  - syllabus implementation
- 9.2 Simulator Training
  - training functions
  - training techniques
  - evaluation
  - simulator instructing
- 9.3 Simulator Syllabus Development
  - training objectives embedding
  - performance criteria allocation
  - formatting/programming
  - evaluation
  - support material requirements
- 9.4 Training Standardization
  - event implementation
  - performance evaluation

X PEER/SELF TRAIN FUNCTION

- 10.1 Simulator Operation
- 10.2 Syllabus Lockouts
  - scheduled events
  - performance problems
  - data access
- 10.3 Training Controls
  - performance evaluation
  - diagnostic controls

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APPENDIX C  
DEVICE 2E6 OPERATING FLOW CHARTS



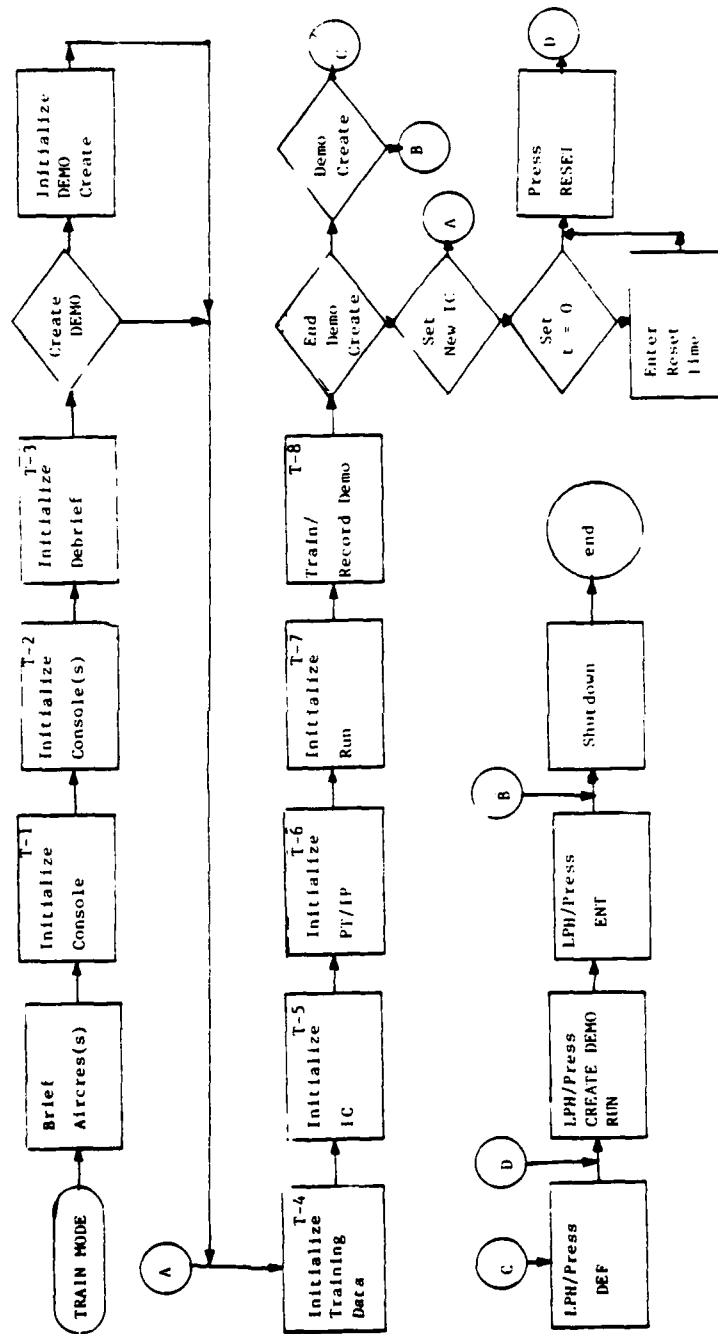


Figure C-1. Train mode task flow

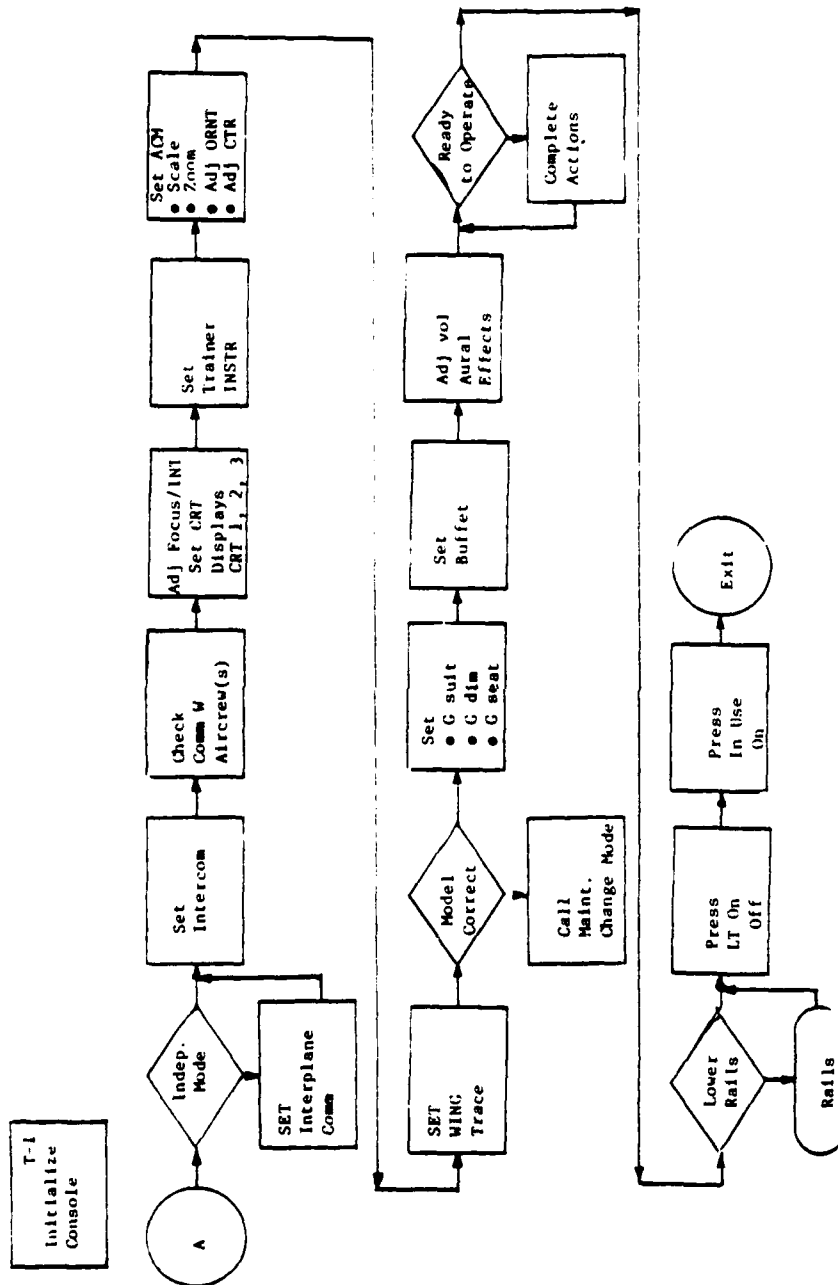


Figure C-2. Initialize console sub flow

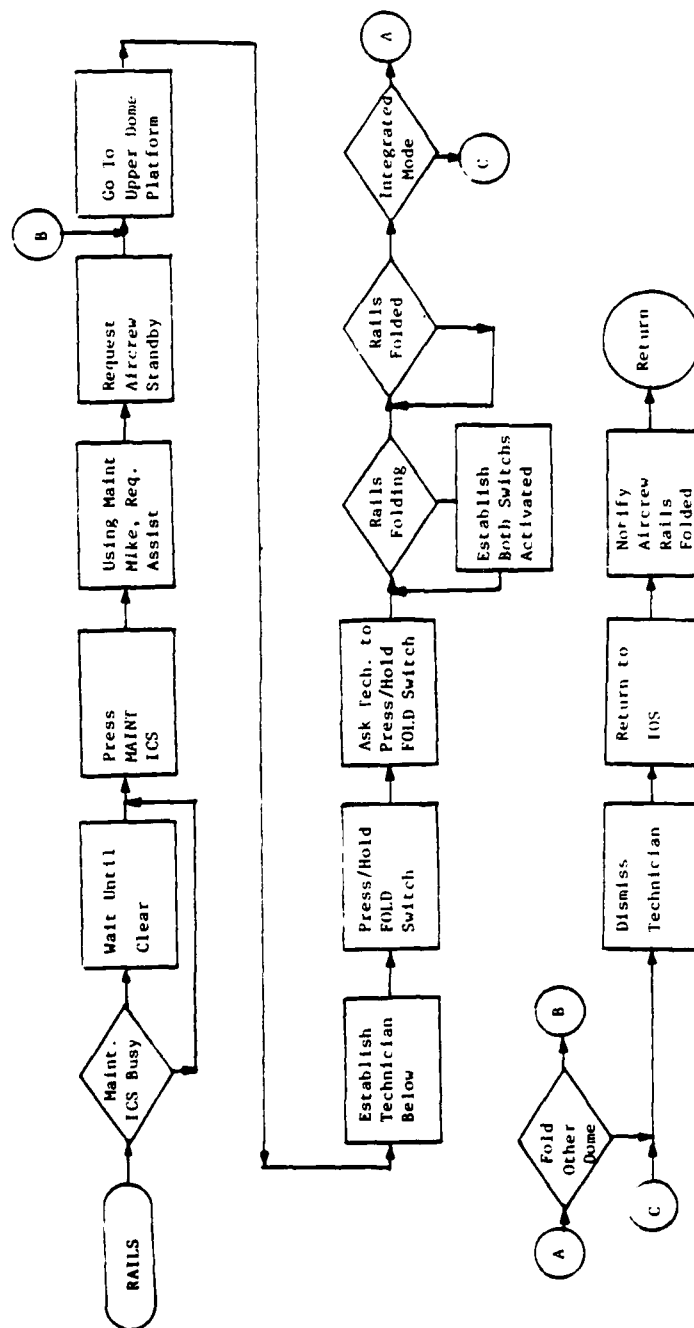


Figure C-3. Ralls sub flow

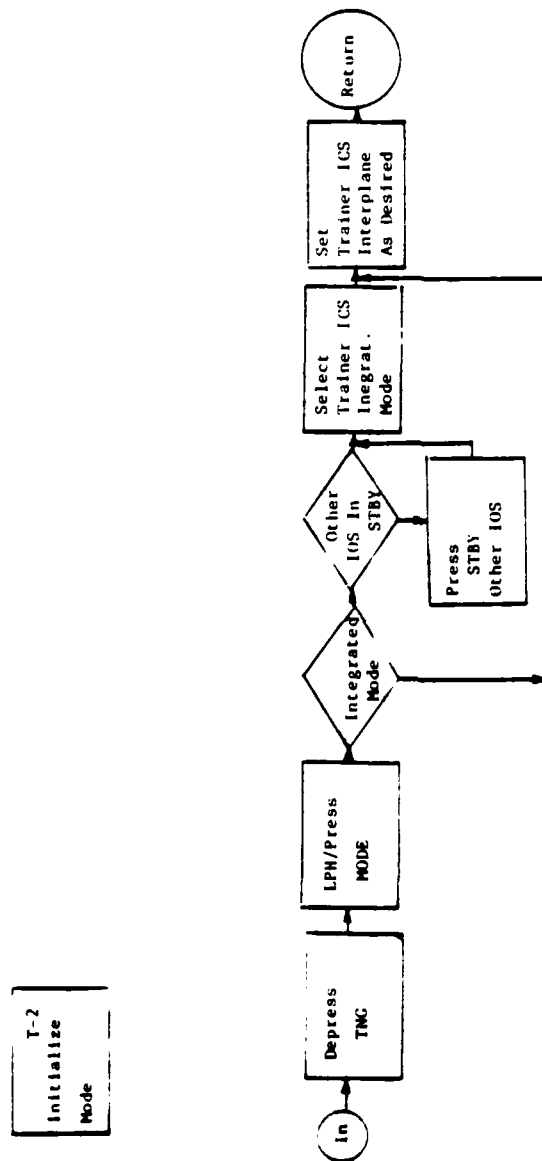


Figure C-4. Initialize mode sub flow

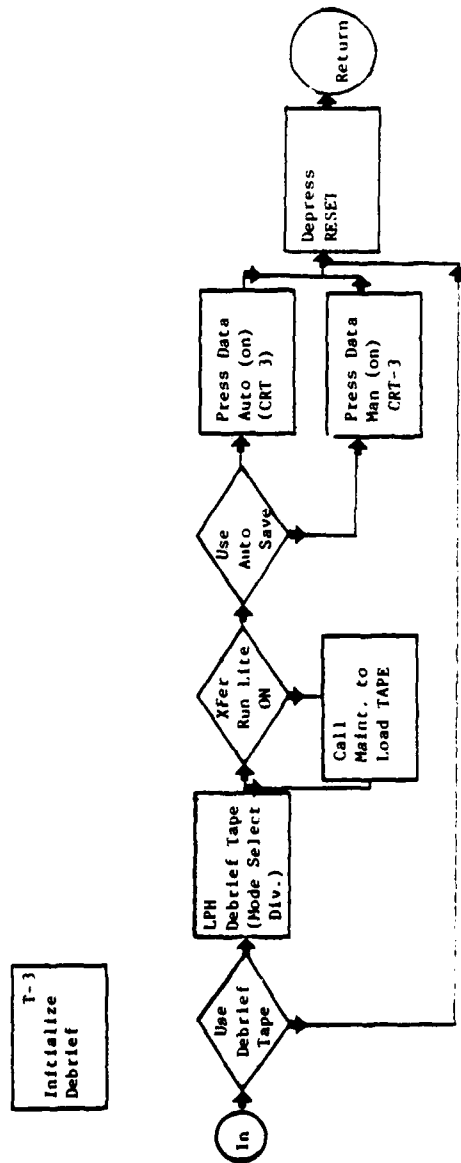


Figure C-5. Initialize debrief sub flow

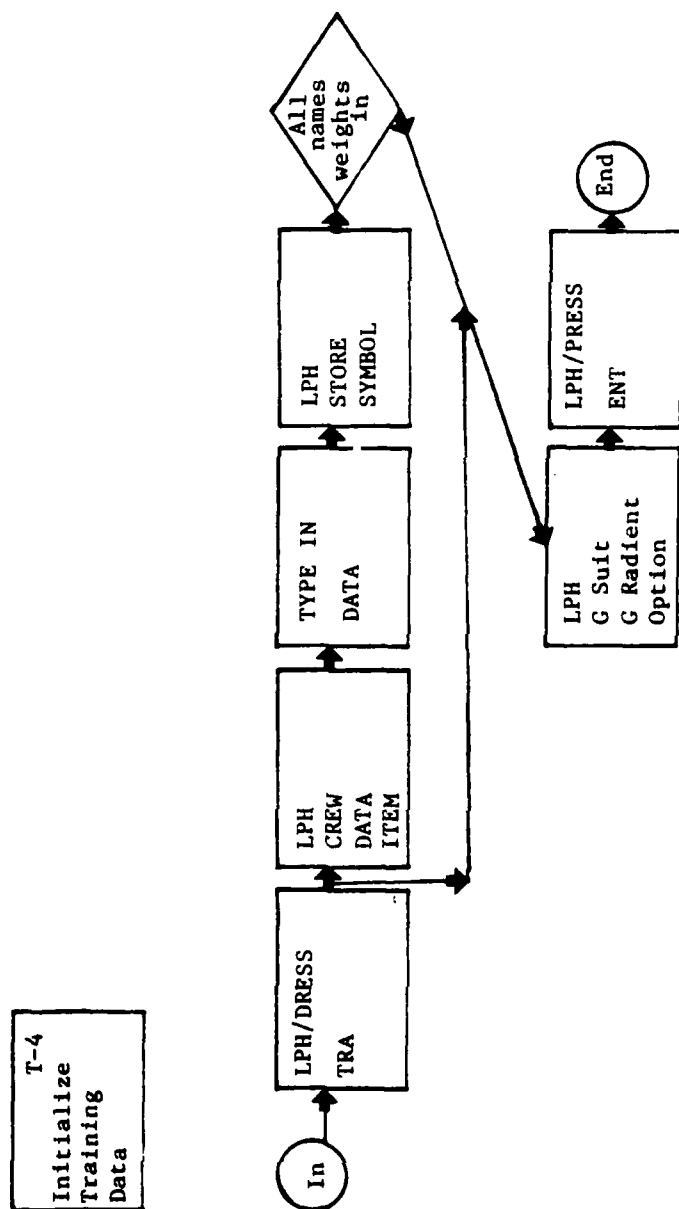


Figure C-6. Initialize training data sub flow

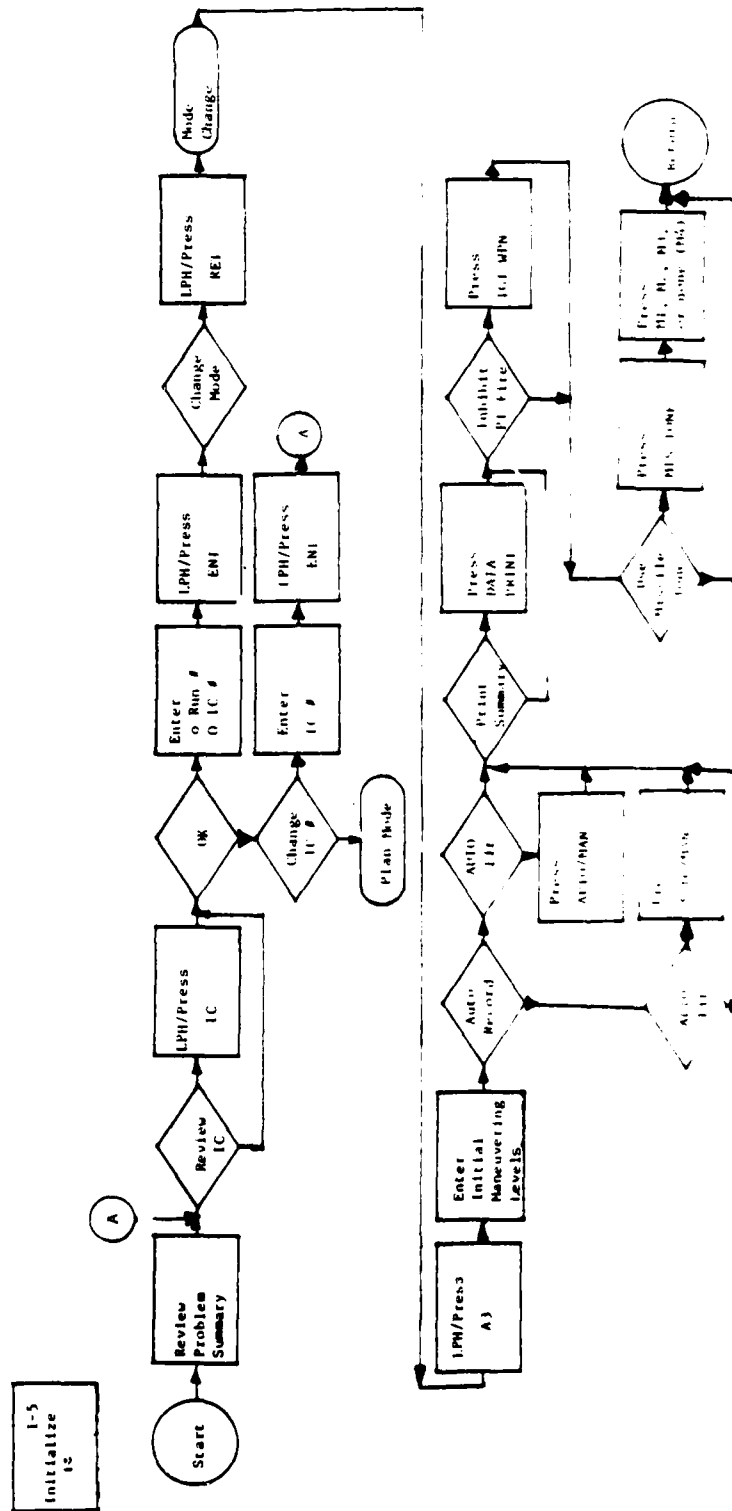


Figure 6-7. Internalize to sub flow

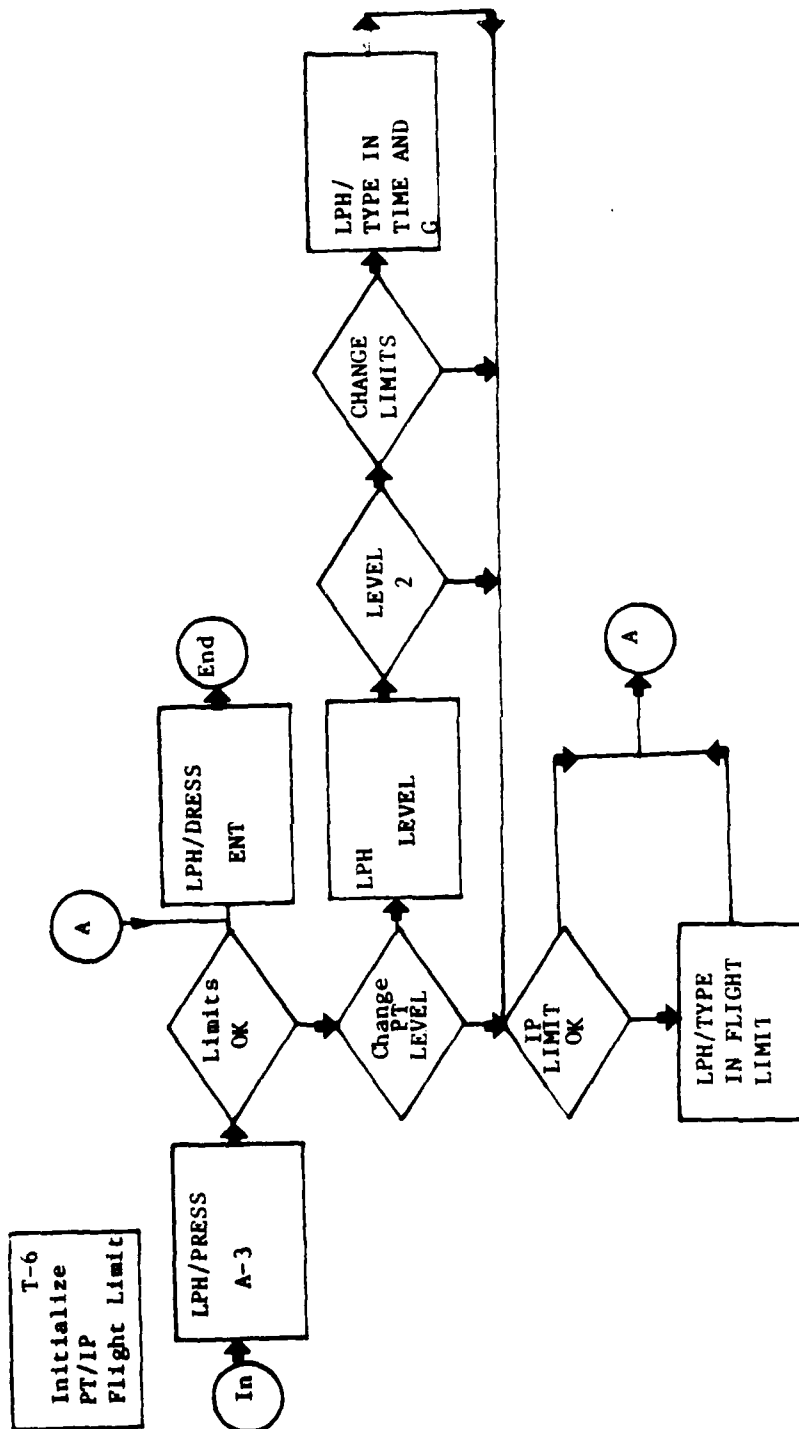


Figure C-8. Initialize PT/IP flight limit sub flow



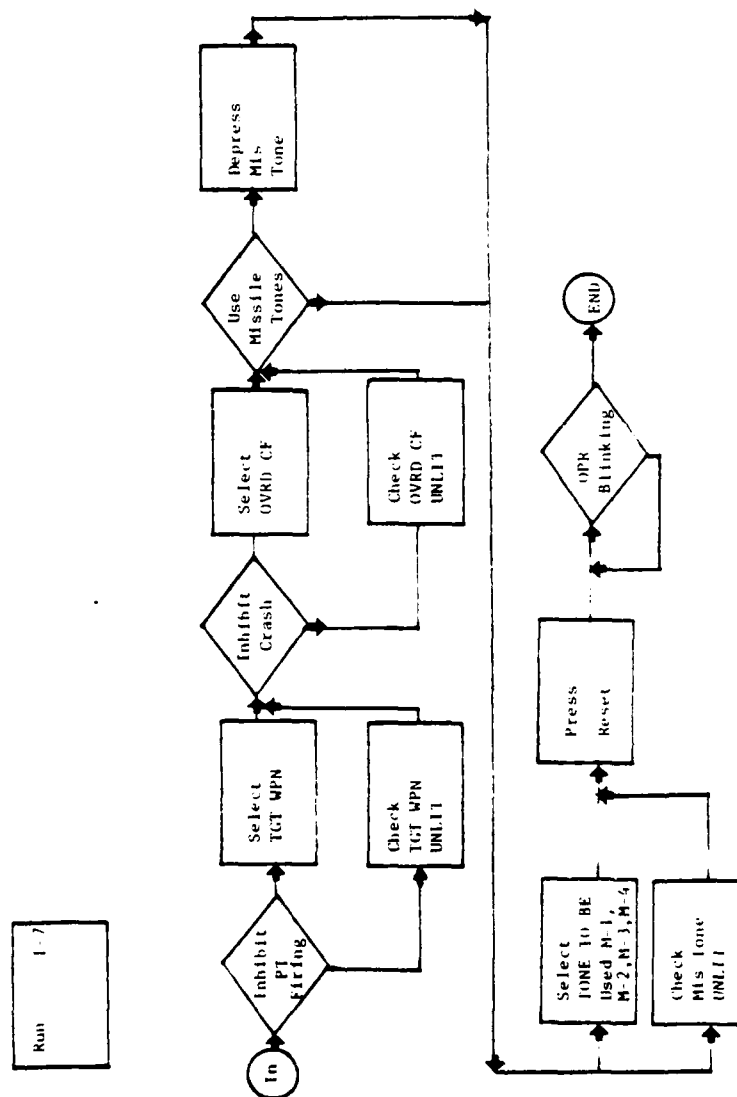


Figure C-9. Run sub flow

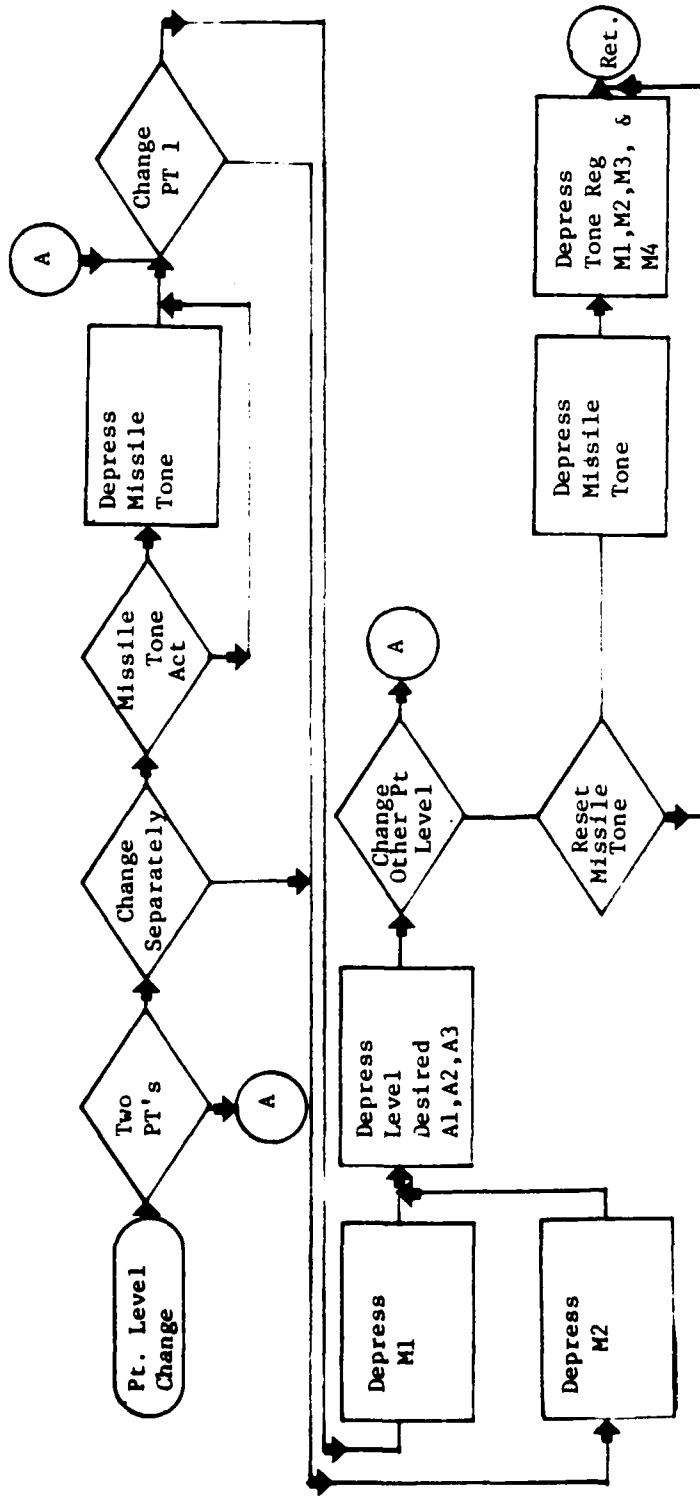


Figure C-10. PT level change sub flow

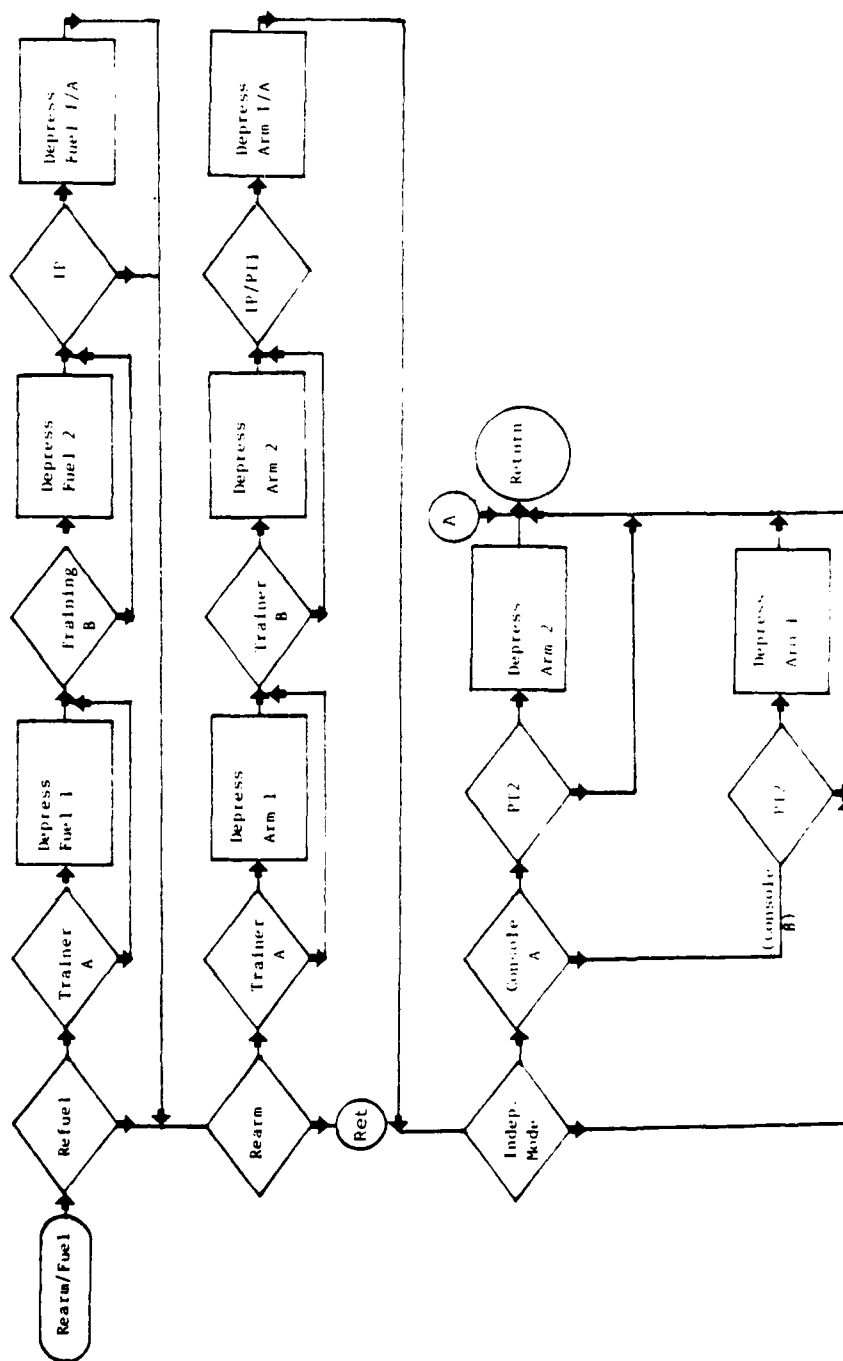


Figure C-11. Rearm/fuel sub flow

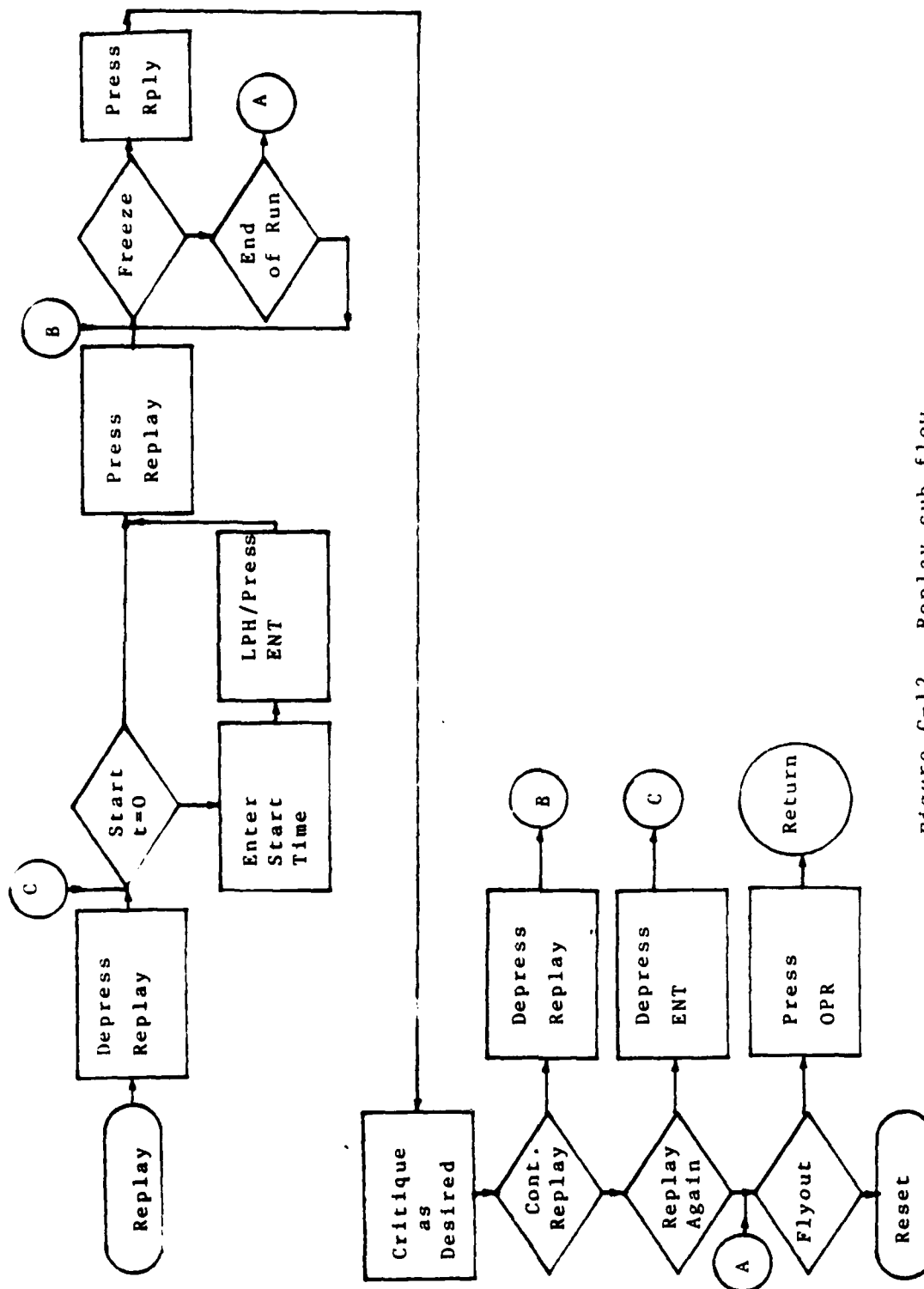


Figure C-12. Replay sub flow

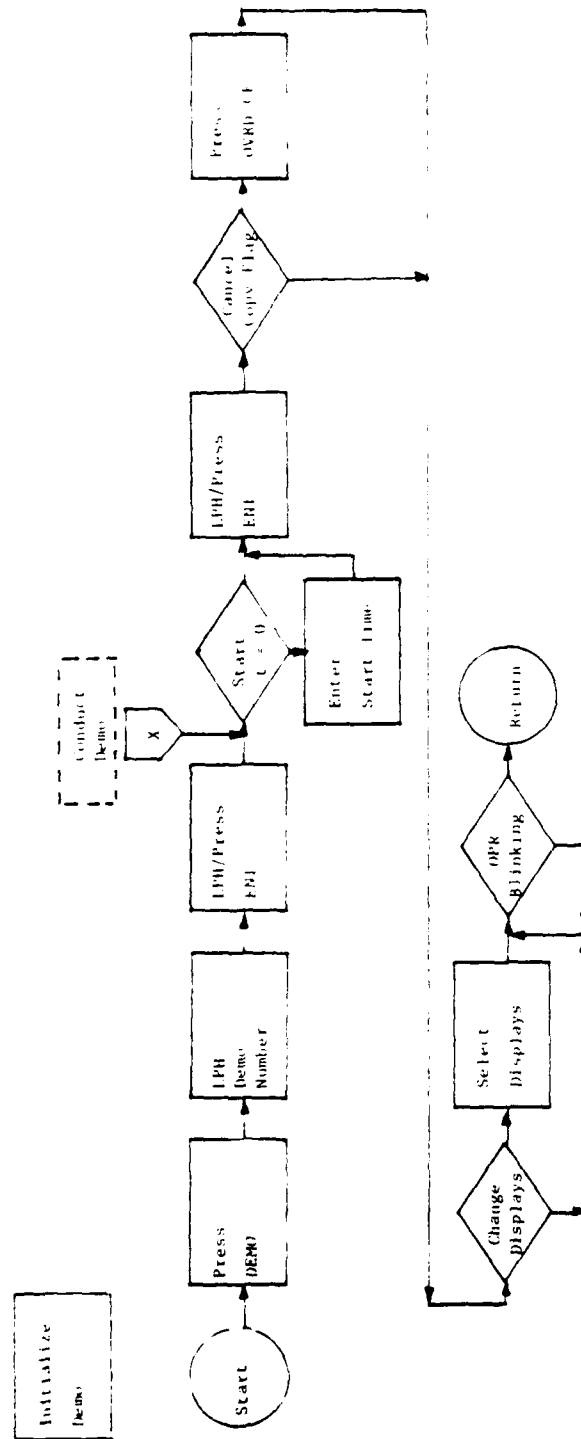


Figure C-13. Demo mode task flow (1 of 2)

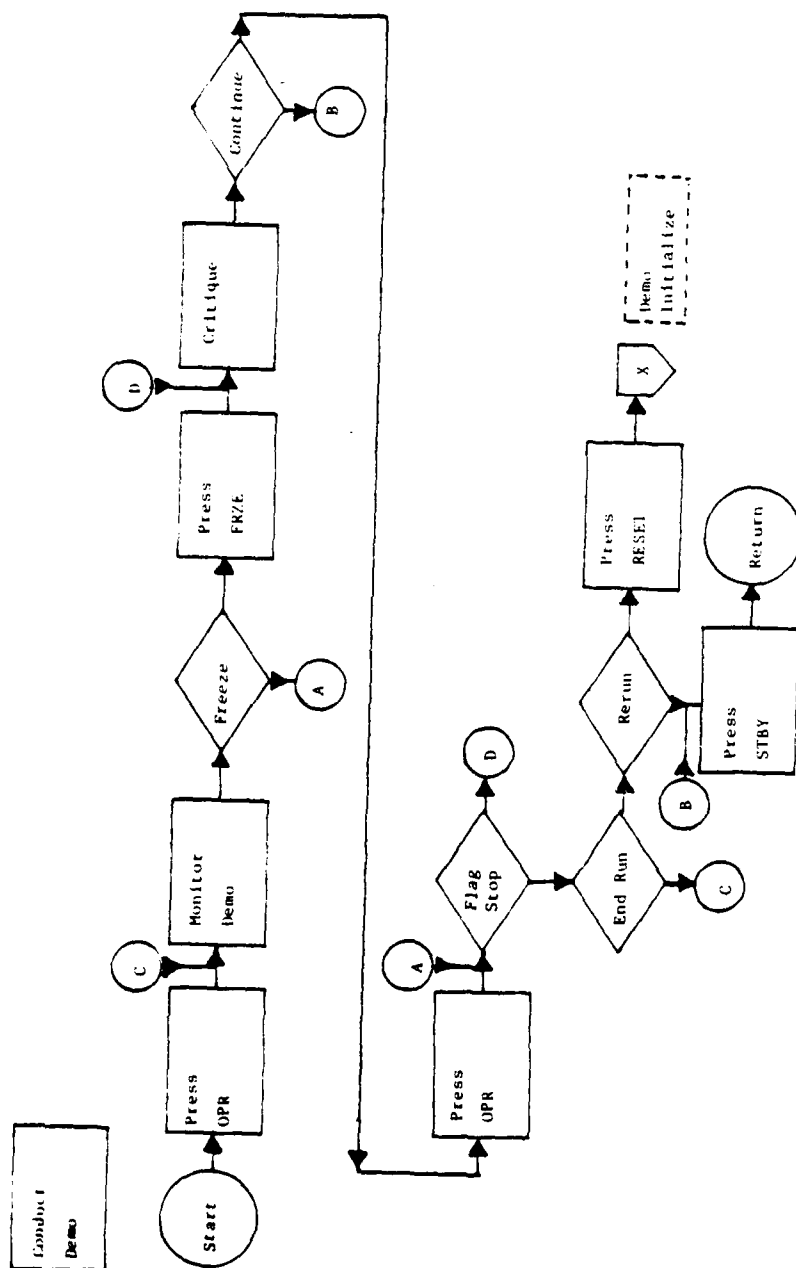


Figure C-13. Demo mode task flow (2 of 2)

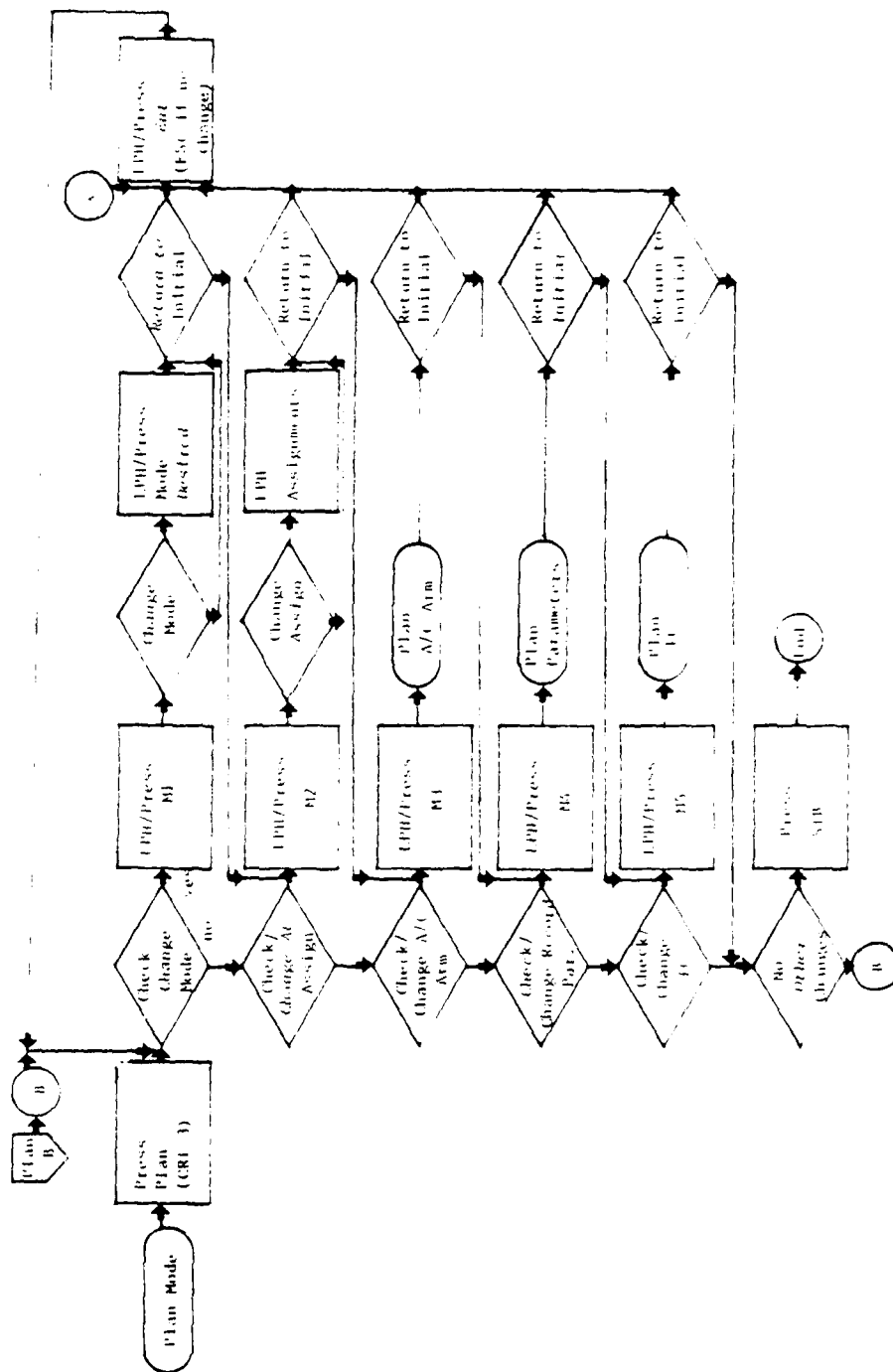
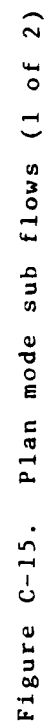


Figure C-14. Plan mode task flow





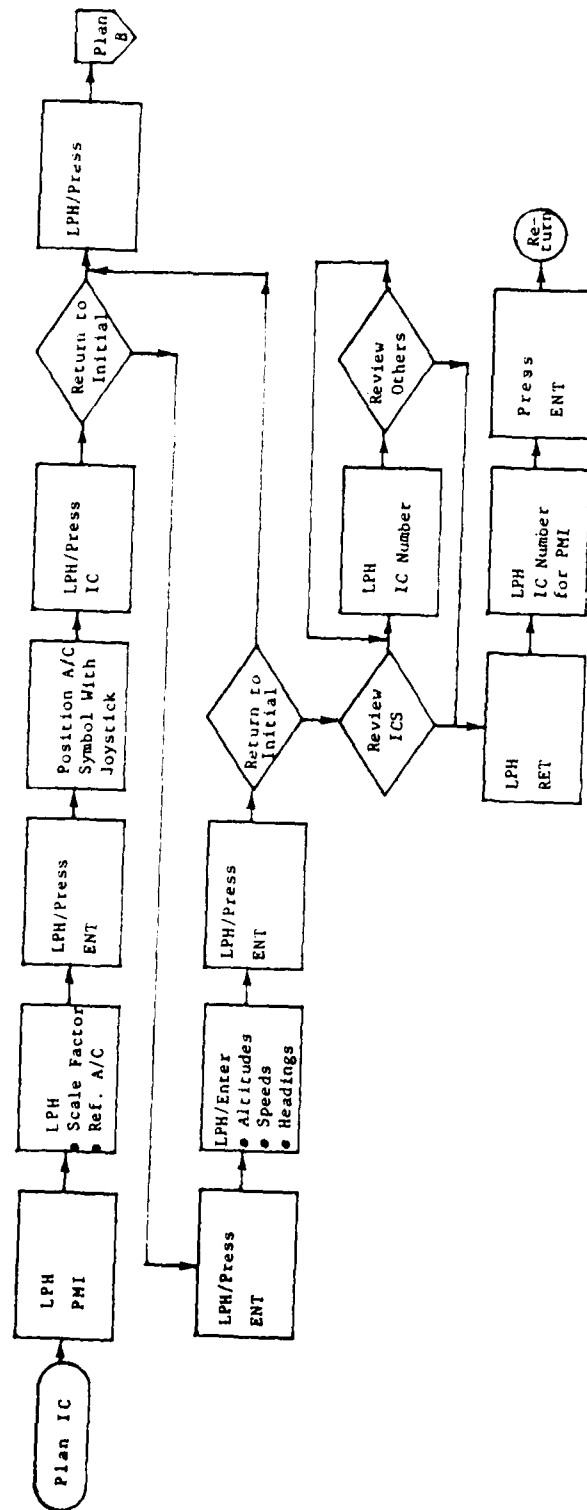


Figure C-15. Plan mode sub flows (2 of 2)

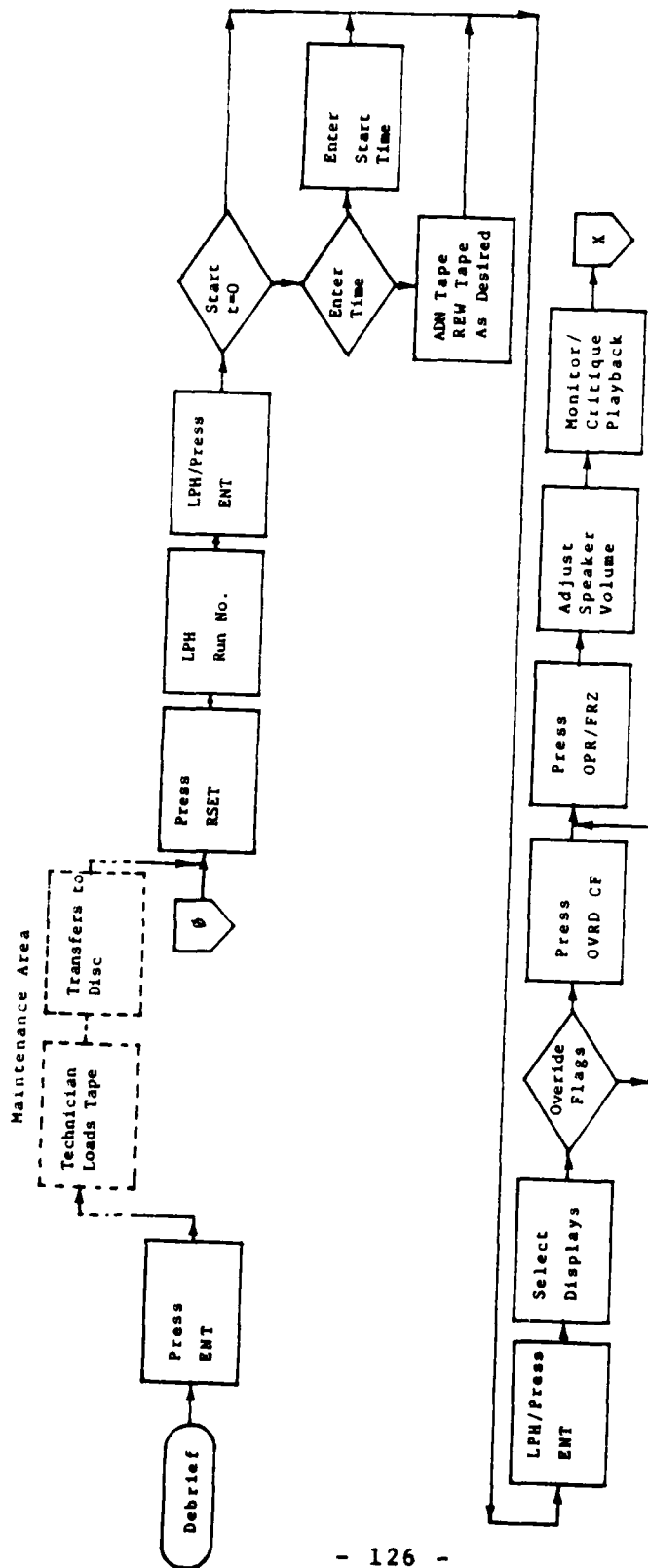


Figure C-16. Debrief mode task flow (1 of 2)

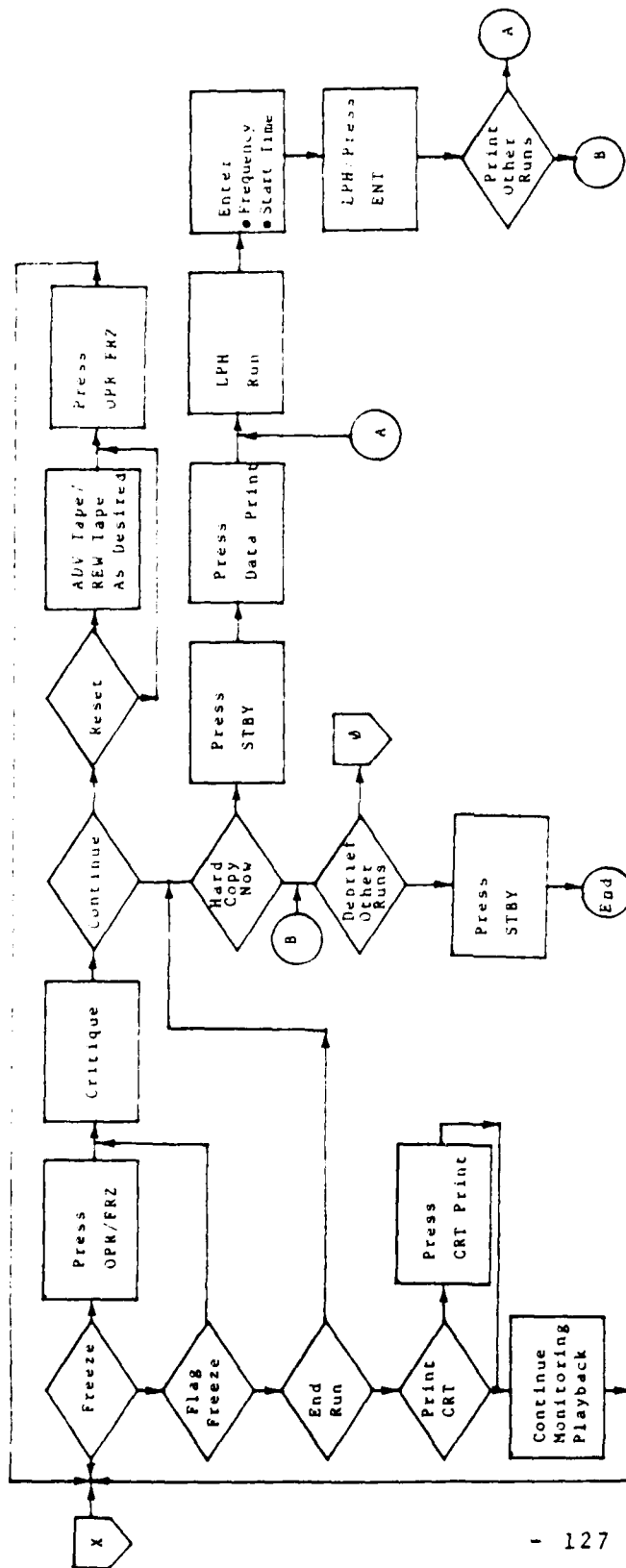


Figure C-16. Debrief mode task flow (2 of 2)

## GLOSSARY

ACM	Air Combat Maneuvering
ACMS	Air Combat Maneuvering Simulator
ADI	Attitude Director Indication
ANKB	Alpha-Numeric Keyboard
BDHI	Bearing-Distance-Heading Indicator
CDP	Control Display Problem (numbered)
COMFITWING	Commander Fighter Wing
COMNAVAIRLANT	Commander Naval Air Force Atlantic
CRT	Cathode Ray Tube
DEMO	Demonstration
DET	Detachment
FASOTRAGRULANT	Fleet Aviation Specialized Operational Training Group Atlantic
FFARP	Fleet Fighter ACM Readiness Program
FRS	Fleet Readiness Squadron
FRZE	Freeze
IC	Initial Condition
ICS	Intercommunication System
IOS	Instructor Operator Station
IP	Instructor Pilot
IRIO	Instructor Radar Intercept Officer
ISS	Instructor Support System
LP	Layout Problem (numbered)
MIL STD	Military Standard
MO	Mission Operator
NAS	Naval Air Station
NAVTRAEQUIPCEN	Naval Training Equipment Center
NFO	Naval Flight Officer
NKB	Numerical Key Board
OCV	Out-Of-Cockpit-View (display)
OP	Operating Problem (numbered)
PT	Programmed Target
PWR	Power
RDY	Ready
RIO	Radar Intercept Officer
RPLY	Replay
RSET	Reset
TGT	Target
TNG	Training
VF	Fighter Squadron
WST	Weapon System Trainer
XFER	Transfer

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Binghamton, NY 13902

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National Research Council  
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